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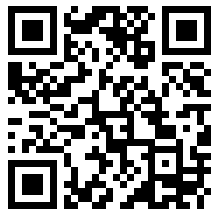

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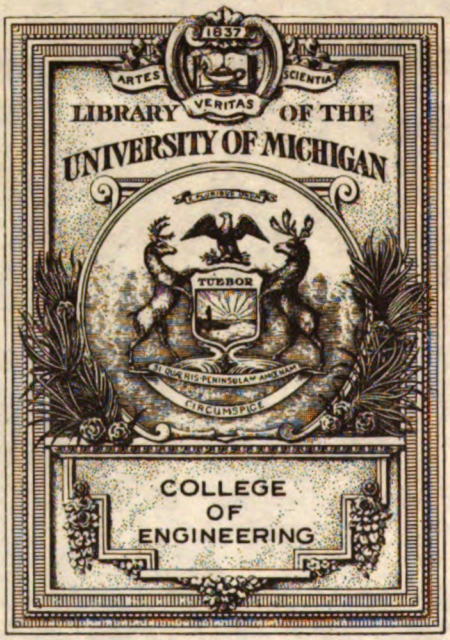

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Popular Radio

JULY 1923

20¢

In this Number

How to Install Your Radio on Your Boat

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Get Long Range *with RCA radio-frequency transformers*

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$6.50

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—To make a small inside loop reach as far as an outside antenna.

—To increase tremendously the range of an outdoor aerial without distortion.

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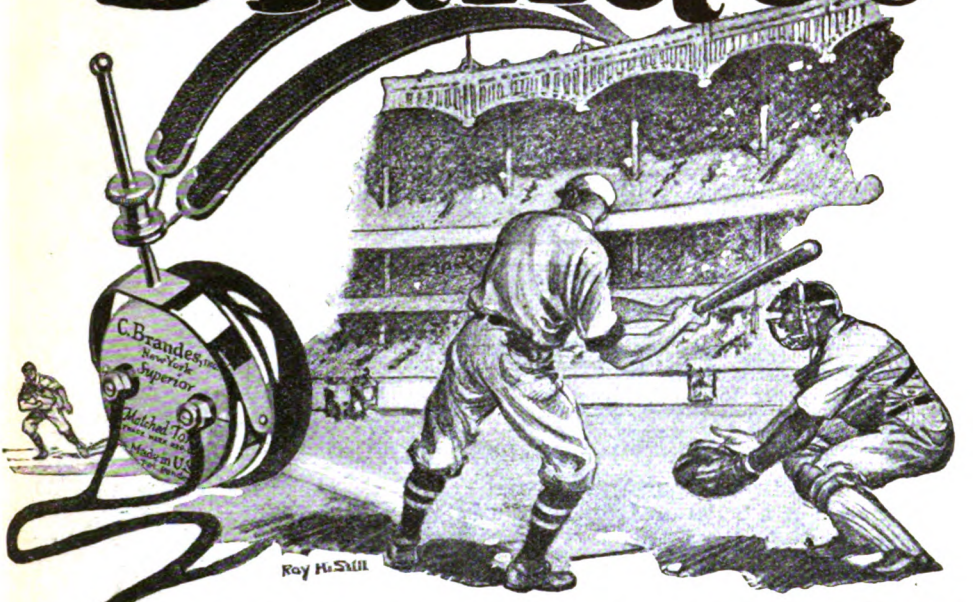

TWO OUT *and the* BASES FULL!

The count stands three and two and the next pitch tells the story—did he fan or walk, or did he sew up the game with a clean single?

Never a chance of being interrupted at an exciting moment by trouble in your headset. Never a chance of losing any part of the program which your set picks up—if you have a Brandes *Matched Tone* Headset.

Brandes tells the story clearly—every word of it. Brandes gets everything out of your set—and gets it all the time.

C. BRANDES, Inc., 237 Lafayette Street, N. Y.
Distributors in Australia and New Zealand: International Electric Co., Wellington, N. Z.
Made in Canada and England by Canadian Brandes Ltd., Toronto and London
Distributed in Canada by Perkins Electric Ltd., Toronto–MONTREAL–Winnipeg

Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(Cover design by Frank B. Masters)

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VOLUME IV JULY, 1923 NUMBER 1

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

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A PAGE WITH THE EDITOR

THE new Four-Circuit Tuner—not only announced for the first time in the May number of POPULAR RADIO but described in specific detail by the inventor, Laurence M. Cockaday—"went over with a bang" in the words of one ardent reader. Certainly no receiving set has been acclaimed so universally or so promptly or so enthusiastically in the whole history of radio.

* * *

AND despite the becoming modesty of its inventor, who insisted upon naming his brain-child the "Four-Circuit Tuner," the set has, properly enough, assumed the name of its father, and is usually referred to as "the Cockaday set." Which is fair enough!

* * *

"THE Cockaday set is the greatest asset to the radio public today," writes C. J. Hauff, of New York. And Mr. Hauff's comment is quoted here not because it is exceptional but because it is representative of the comment that reaches us by mail, telegraph, telephone and radio.

* * *

MR. HAUFF is not commenting from hearsay, either. He is one of the army of real fans who actually built the Cockaday set within a few hours from the time his May copy of POPULAR RADIO reached them.

* * *

IT was not until four whole days after the May issue was published, however, that Mr. Hauff reported:

> "Right after I finished building the set I picked up KDKA, KYW, WDAP, WBZ, WOC, WHAS and CFCA, although the local broadcasting stations were broadcasting at the time. And I also picked up amateur transmission from the 1st, 2d, 3d, 4th, 5th, 8th and 9th Districts and from numerous Canadian stations."

* * *

ON the morning after the May number was published, Mr. Cockaday received six telephone calls from fans who had stayed up all night to build the new set and who wanted to report that it was "working fine."

* * *

FROM L. B. Barret, of Bangor, Maine, comes this unusual report of his experience with his new Cockaday set:

"Last night, while listening to WGY on the loudspeaker, I removed the antenna—but I still heard the voices. I then removed the ground, yet I could yet hear the voices on the earphones. No ground—no antenna—yet the voices were still audible. I consider that remarkable!"

* * *

FOR the benefit of those of our subscribers who change their addresses and who (naturally) do not want to miss any copies of POPULAR RADIO, our Subscription Manager offers the following word of advice:

In sending a notification of change of address, a subscriber should give both the old *and the* new *address. In order to have the change become effective with the next issue, the notification must be received by the Subscription Department not later than the first of the month preceding the date of next issue.*

* * *

"RADIO is just now the great boon of the boy. The ether is his plaything and he sports with its waves as in a swimming hole. The excellent popular-science journals that have done so much to teach and stimulate the American boy have crowded the dime novel off his bedroom shelf."

—SATURDAY EVENING POST

POPULAR RADIO rises to acknowledge the compliment, blushing to the roots of its conventional hair.

* * *

WHEN POPULAR RADIO took the initiative among the radio magazines and undertook to have its circulation records *certified*, it entered upon a policy that met with the instant endorsement of advertisers and advertising agencies alike. For after all, an advertiser pays for *circulation;* in justice to him as well as in his protection, the circulation figures should be more than a mere matter of assertion or hearsay; they should be a matter of open, certified record.

* * *

THIS policy is now being further extended—and again in the protection of the advertiser. From the advertising manager comes this significant announcement:

"With its October issue, this magazine guarantees an average net sale of 100,000 copies a month, or pro-rata *refund* to all advertisers.

"For this circulation, the rate will be $200 a page, $100 a half page, and $50 a quarter page.

"POPULAR RADIO was the first magazine in its field to publish a certified statement of past circulation. It is now the first to guarantee future circulation—*to agree to deliver to advertisers the circulation they pay for.*"

* * *

"SQUIERCASTING is certainly a good term to apply to wired wireless," writes Henry J. Conant of New York. "But why not be a regular sport and call it *Sqwirecasting?*"

Honestly now, Henry, do you think that General Sqwire would regard this as such an all-fuiered good term for wuiered wuierless?

* * *

To "see ourselves as ithers see us" is not an invariable comfort. Here, however, is a copy of a confidential report on POPULAR RADIO that was recently sent by a disinterested investiga-

(Continued on page 8)

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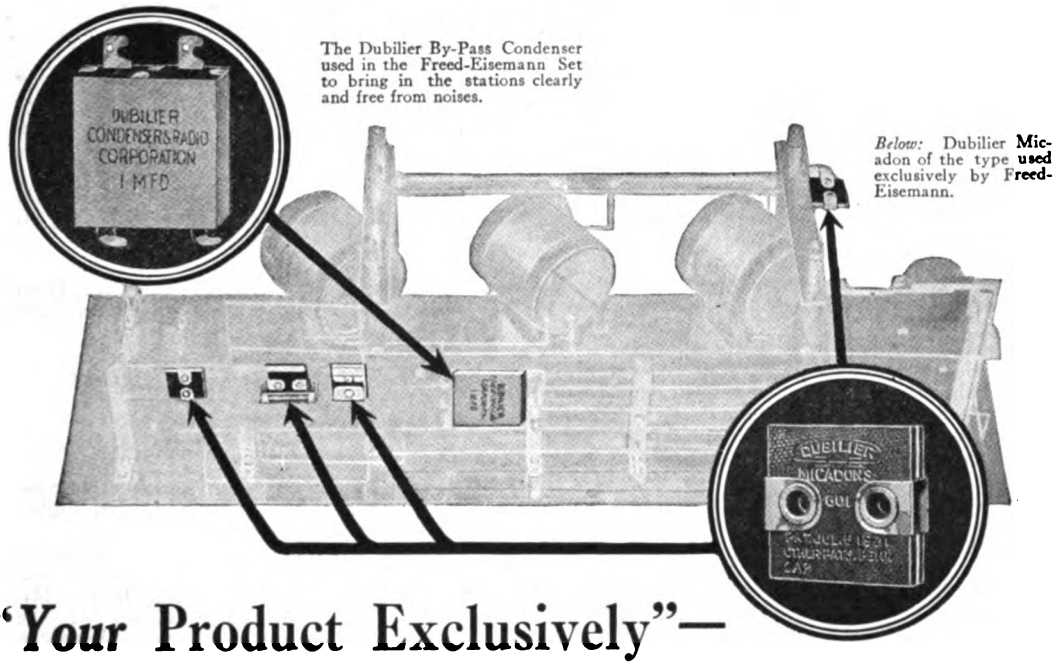

The Dubilier By-Pass Condenser used in the Freed-Eisemann Set to bring in the stations clearly and free from noises.

Below: Dubilier Micadon of the type used exclusively by Freed-Eisemann.

"*Your* Product Exclusively"—

IN the Freed-Eisemann five-tube Neutrodyne receiver Dubilier Micadons are used exclusively.

"We conducted experiments which caused us to decide on *your product exclusively*," writes the Freed-Eisemann Radio Corporation to the Dubilier Condenser and Radio Corporation.

In order to balance capacities in the Neutrodyne circuit and to avoid losses, only condensers *permanent in capacity* can be used.

Because Dubilier Micadons alone meet these requirements they are used not only in the well-known Freed-Eisemann set but in Paragon, Zenith, Fada, De Forest and other sets which have won the approval of the radio public.

Unless a set is equipped with Dubilier Micadons, there is unnecessary howling and whistling. The broadcasting station is not heard at its best.

Price 35 cents to $1.50 each.
At all good dealers.

DUBILIER CONDENSER AND RADIO CORPORATION
48-50 West Fourth Street, N. Y.

BRANCH OFFICES IN THE FOLLOWING CITIES:

Los Angeles, Cal. — **Huntington, W. Va.**
St. Louis, Mo. — **Washington, D. C.**
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DUBILIER PRODUCTS

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A PAGE WITH THE EDITOR

(Continued from page 6)

tor to one of the world's foremost scientists who has consistently refused to contribute to the magazines—but who, happily, made an exception in our case:

"POPULAR RADIO is the most conservative, dignified and authoritative magazine of radio, simply not to be compared with — — and other magazines which are simply the yellow journals of radio. It is the only magazine which consistently obtains specially prepared material from such persons as Elihu Thomson, Prof. J. H. Morecroft, Senator Marconi, Dr. Lee De Forest, John Hays Hammond, Jr., Charles P. Steinmetz, Sir Oliver Lodge and probably half a dozen equally as well known in the field. At the same time it is the most successful and highest-circulating magazine of any published and actually goes to a very discriminating audience. All this is simply to show that it keeps good company and I honestly believe that it hurts no one's standing to be seen in it."

* * *

WE have only one flaw to pick in this otherwise perfect recommendation. While we concur in the opinion that to contribute to our pages can "hurt" not even the most exacting scientist, we can even go so far, under pressure, as to admit that it will make him famous! Too many real scientists are known only to a small group of fellow-workers, who *should* be known to a large public—particularly to that discriminating part of it that read POPULAR RADIO.

* * *

THE avalanche of inquiries that keep pouring into the office of the Technical Editor from readers who have problems to solve, furnish gratifying evidence of the increasing value of the Technical Editor's advice. But despite the additions to our technical staff the questions from readers are increasing in even greater ratio—with the result that we have been at a loss as to just how we can be of service to so many of our good friends all at once!

* * *

IF we could only line up all of our correspondents so that they could *see* each other we could at least show the reasons for the delays in answering their letters and amiably advise them that "the line forms on the right; please do not shove."

* * *

BY the time that this issue goes to press, however, the Editor hopes and believes that the pile of unanswered letters will have been materially reduced if not eliminated altogether. For we have called in not merely *one* additional technical expert, but a staff of several experts who will remain on the job until all the hold-over correspondence has been cleaned up.

* * *

"IF you can't answer my inquiry promptly," writes a ruffled reader, "I know plenty of radio editors who will be only too glad to."

Well, so do we. That is one reason why POPULAR RADIO takes such particular care in preparing its replies—and that care takes time.

* * *

PERHAPS that suggests *one* of the reasons why more and more readers are turning to POPULAR RADIO for technical advice!

* * *

THIS cheerful burst of song comes from Toronto, Can. The Editor appreciates both its theme and its technical excellence:

A happier boy in all this land
You could not find, when in my hand
I hold that wonderful—yes, quite so—
That wonderful POPULAR RADIO!

S. B. PETCH

* * *

ON page 280 of our April number we published a picture of an interesting and highly efficient receiving set that was designed for the special use of lighthouse keepers; information came to the Editor that this apparatus was designed by the Bureau of Standards. Mr. A. W. Tupper, assistant engineer of the Bureau of Lighthouses, notifies us, however, that the set was designed by his bureau. POPULAR RADIO gladly re-locates the credit for the design of this excellent receiver.

* * *

"I HAVE built fifteen sets of different designs and tried many hook-ups," writes E. H. Severson of Binghamton, N. Y., "but I am getting better results from the DX set described in your January number than from any set or hook-up that I have ever tried."

* * *

If you see it in POPULAR RADIO, *it's so!*

* * *

JUST exactly what do *you* like best in POPULAR RADIO? For what specific feature or features do you select it in preference to the many radio magazines?

To find out the answer, we recently sent out 3,500 questionnaires to a selected list of subscribers. Of the first 650 replies that reached us (several of them by telephone and telegraph) we have made a careful, detailed analysis. The results conclusively show that—

* * *

BUT just look through this number and decide for yourself what effect these replies have had on the magazine. Unless the results *show*, our trouble and expense in meeting your desires are in vain!

Kendall Banning

Editor, POPULAR RADIO

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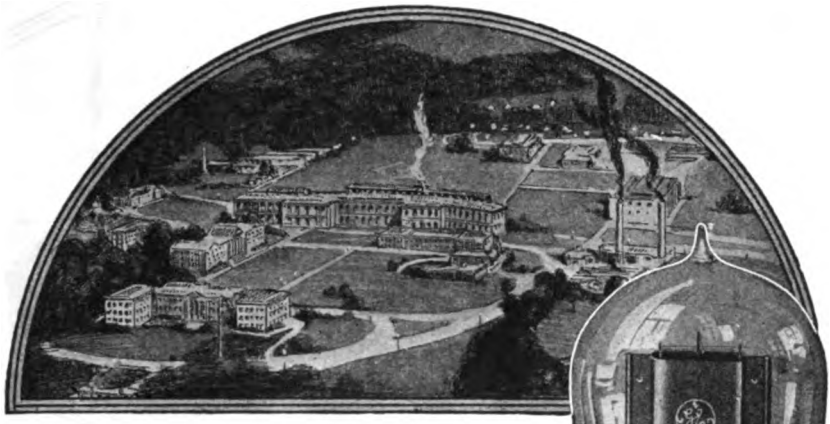

One of the World's Largest Manufacturers with unlimited resources Builds Cunningham Tubes

FORTY-THREE years ago the carbon filament electric lamp, at that time considered the finest development in the electrical art, came into general use.

The important and ever-growing demand resulted in the building and expansion of mighty factories, and the improvement of factory methods, until today the tungsten filament gas-filled lamp yields eight times the candle power for the same electric input.

In recent years these same highly skilled manufacturers have been devoting a part of their factories, and applying their engineering talent gained through years of experience, to the production of vacuum tubes.

The new Cunningham type C-301-A, Amplifier and Detector represents a combination of these years of manufacturing experience, and the engineering ability contributed by that great scientific organization, the Research Laboratory of the General Electric Company.

The low filament current of only one-fourth of an ampere and the extremely high mutual conductance of 700 micro-ohms, make the C–301-A the most efficient vacuum tube ever built for amateur and entertainment use in radio.

A Specially Designed Tube For Every Radio Use

Patent Notice: *Cunningham tubes are covered by patents dated 11-7-05, 1-15-07, 2-18-08, and others issued and pending. Licensed for amateur, experimental and entertainment use in radio communication. Any other use will be an infringement.*

C. J. Cunningham Inc.

Home Office:
248 First Street
San Francisco, Calif.

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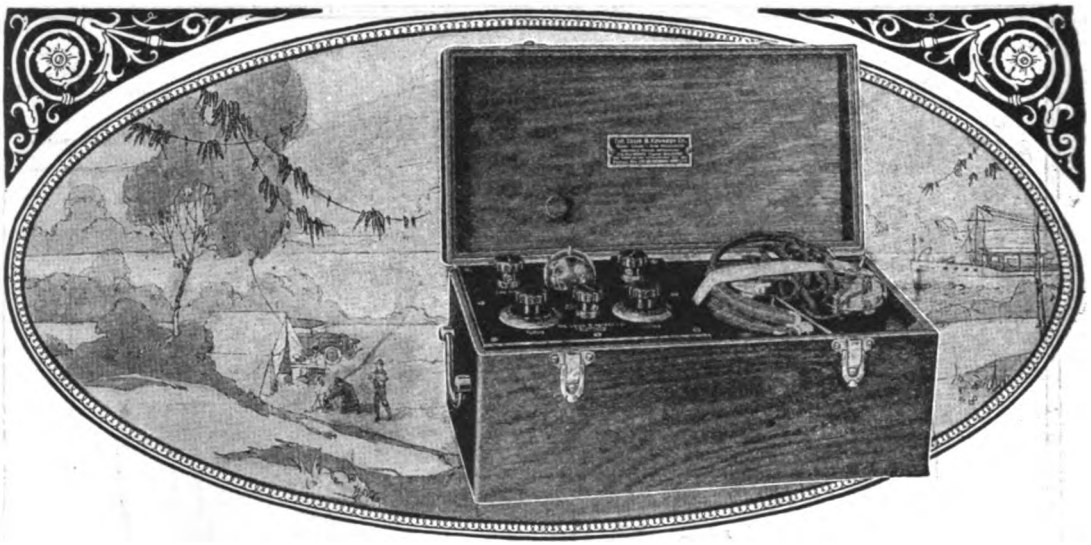

Take This Radio Set on Your Outings!

Enjoy Radio concerts at your summer cottage.

A welcome addition to the camper's kit.

Take it with you wherever you go.

All Kennedy Receiving Sets are regenerative—licensed under Armstrong U.S. Patent No. 1,113,149.

A New Kennedy Achievement—Light, Compact, Portable, Highly Efficient

Here is the ideal Summer Radio Set! Just the thing to take with you on your vacation—auto touring, boating, camping, or to your summer cottage. A handy, compact set, so easily transported from place to place that you can take it with you wherever you go—yet so exquisitely finished that you will be glad to have it in your home.

Reduces Interference

This new set is the latest triumph of the Kennedy Engineering staff. It has all the beauty, refinement and perfection of detail that distinguishes the Kennedy line and makes it the "Royalty of Radio." It is simple to operate, yet highly selective, with unusual freedom from interference—the ideal summer set.

No Storage Battery Needed

The Kennedy "Portable" is designed for use with any standard tube, including the dry-cell type. When dry-cell tube is used, the set is entirely self-contained, space being provided in the sturdy, beautiful oak cabinet for dry batteries and phones. Size 15x7½x7, weight 17 lbs. Complete, with tube, dry batteries and phones, $75.00.

See the nearest Kennedy dealer for demonstration, or write for descriptive literature on this and other Kennedy sets.

THE COLIN B. KENNEDY COMPANY

SAINT LOUIS SAN FRANCISCO

KENNEDY

The Royalty *of Radio*

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Underwood & Underwood

What Radio Is Bringing to Humanity

"Looking ahead, it is impossible to avoid the conviction that radio is going to create a revolution in the means of transmitting news and views, and that it will be a powerful aid to the education of humanity."

—Sir Philip Gibbs.

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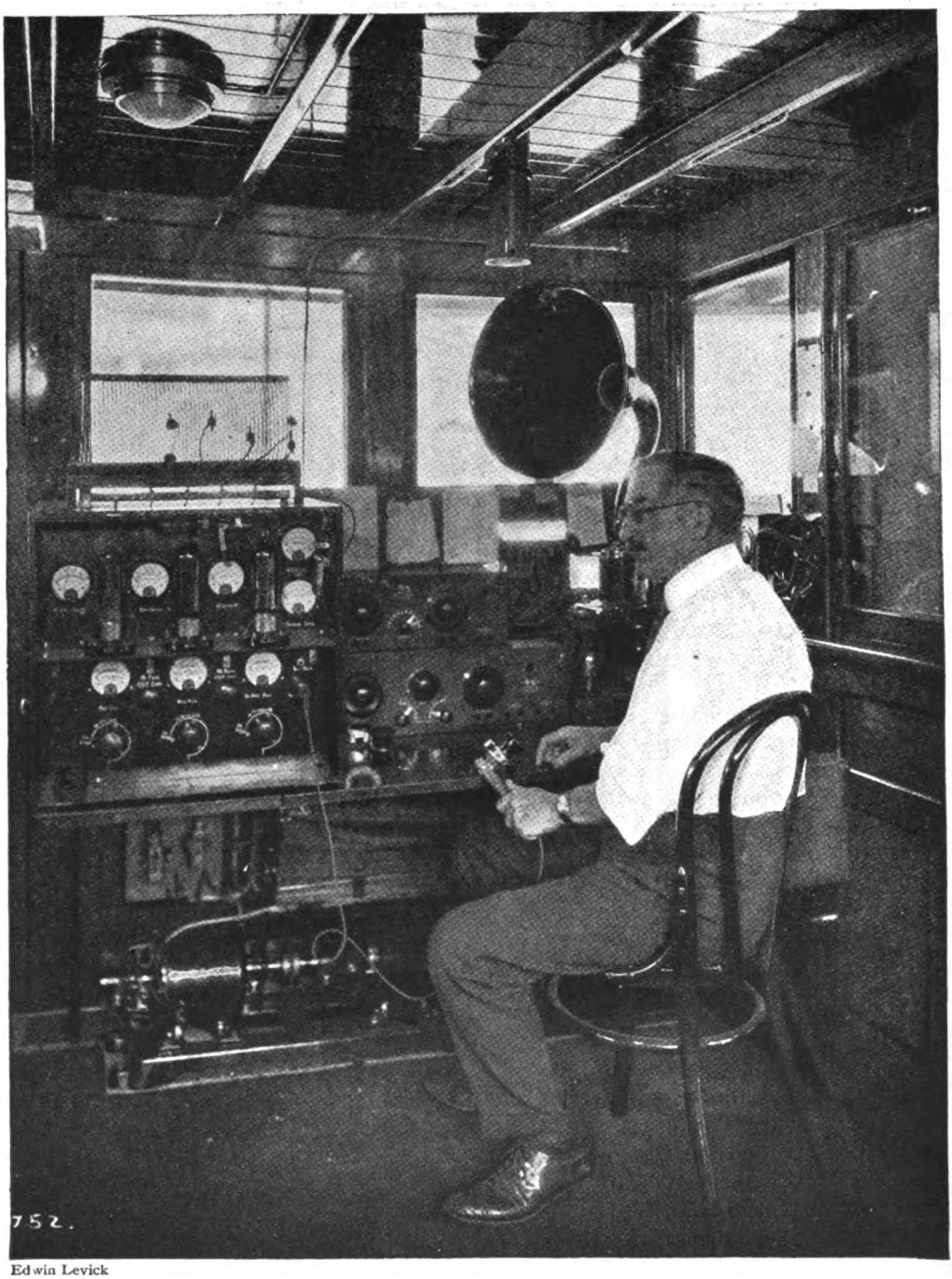

Edwin Levick

A Radio Set for a Tireless Business Man

When Henry B. Joy starts out on a cruise in his 65-foot motor yacht "Spray" he settles down to a period of uninterrupted work in his radio cabin—which comes pretty close to a radio fan's idea of what a radio set ought to be.

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Popular Radio

VOLUME IV JULY, 1923 NUMBER 1

How to Install Your Radio Set ON YOUR BOAT

Take your radio set with you on your vacation! Don't put it aside merely because you have heretofore regarded it only as a medium of indoor entertainment. How to set it up in your canoe, rowboat, launch, sailboat or yacht is here described in specific and practical terms by an experienced radio expert.

By WILLIAM F. CROSBY

A RADIO set installed on the small motor boat or cruiser will probably furnish one of the most popular methods of enjoying the broadcasting during the summer. The obstacles that have heretofore made this form of entertainment impractical have now been overcome.

On the larger motor yachts the installation of a radio set is a simple matter. In the case of the small cruiser, however, difficulties arise that heretofore have made the use of a radio set almost impossible. But the development of the one-and-a-half-volt tube during the last year has changed this situation, and the installation of such a set employing these tubes is both feasible and practical. There is now no reason why the owner of the small boat should not have a small set on his boat. Most of small-boat owners have a decided mechanical bent, and if the directions for making and installing a set given in this article are followed out, no difficulty should arise.

It will be best, at the very start, to eliminate the crystal detector set.

In the first place, the rolling of the boat, combined with the vibrations of the engine, would certainly knock the crystal detector out of adjustment continually. The crystal set will, on the other hand, be suitable for a canoe trip. It must be remembered, however, that the range of a crystal set is strictly limited, and if a lengthy cruise is contemplated, the results will not be satisfactory.

A small set, only seven inches by ten inches, may easily be made up and mounted on a panel. It should contain a vacuum tube and "A" and "B" batteries (if a one-and-a-half-volt tube is used). This set will work well on the small open motor boat, provided that the set is *not* used while the boat is running. It should be used only in the evening, or when the boat is anchored in some snug cove. The antenna wire may be kept on a reel and one of the crew may row ashore with

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one end of it and fasten it up in a tree. The other end of the antenna may be attached to the set on the boat. With an antenna of this kind, about 100 feet long and a good vacuum tube set, results will be as good, if not better than with the same set at home.

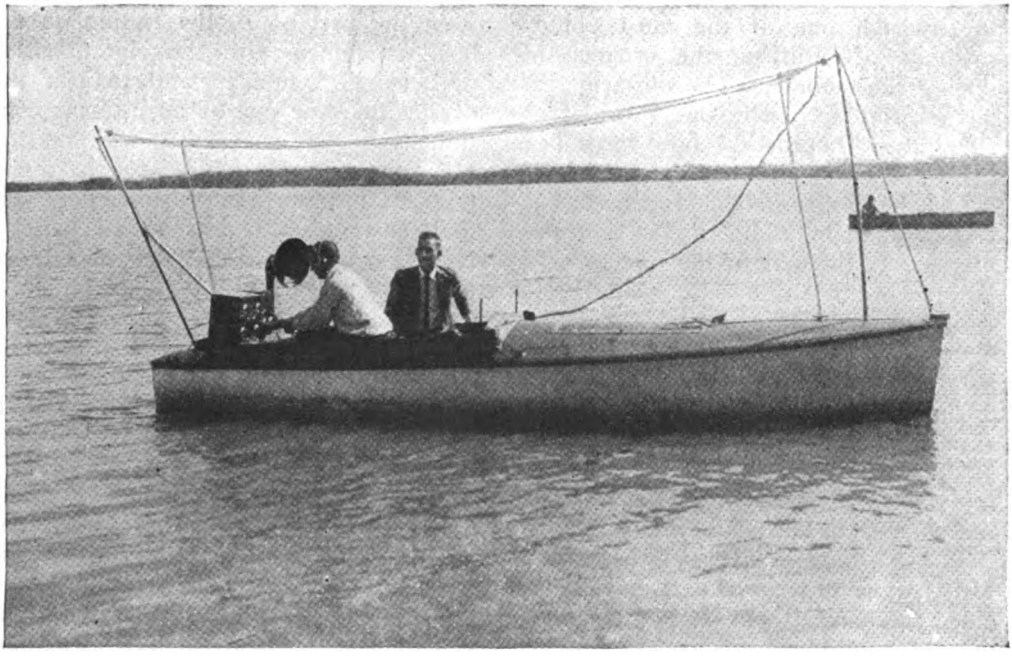
The ground connection on any boat is a comparatively simple problem, but there are a few little kinks that may be well to bear in mind.

For ordinary work, merely the connecting of the ground wire to the propeller shaft will do very well, but better results will be obtained by having a sheet of copper fastened to the outside of the hull, well below the water line.

Solder should *not* be used on the copper sheet, however, if the boat is to be used in salt water, as there will be an electrolytic action between the copper and the solder that will soon eat the solder away. In a boat that has galvanized iron fittings or fastenings there will also be some chemical action on the copper plate; in a case of this kind a zinc plate would be better. The zinc plate, though, will have to be kept a good distance from the bronze propeller and the shaft because, if it is left near the propeller and the shaft, the zinc plate will soon be eaten away.

If a copper plate is used, use copper tacks to hold it to the hull; if a zinc plate is used, galvanized iron tacks should be used for fastening.

For making contact to this plate, a strip of similar metal should be run from just under the sheer moulding to the ground plate. The top end of the metal strip may be run through a small slot in the side of the boat to the inside where an ordinary binding post may easily be attached, which in turn will have a piece of wire running to the set. (See Figure 1A). This metal strip, in case it runs down the outside of the hull, may be let in flush with the planking and painted over, so that you



A PRACTICAL INSTALLATION FOR A LAUNCH

The details of the antenna construction are clearly shown in this view of Fred Mueller's boat on Lake Worth, Texas; it has picked up stations from Denver to Atlanta. The circuit is shown in Figure 3, (pages 14 and 15).

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Kadel & Herbert

MUSICAL INTERLUDES BETWEEN BITES

A receiving set that employs radio frequency and a loop antenna is perhaps the most suitable for a small boat or canoe. This installation was made by William Nigey, while on a fishing trip on the Belgrade Lakes in Maine.

will not be able to see it at all.

So much for the ground connection.

There are many small cruisers which could be easily equipped with radio if the owners only knew of the advantages to be gained. Many of them already have a phonograph on board, but the old records become rather tiresome when an extended cruise is taken. With a radio set on board, different programs may be secured every hour of the day and night, and if a long cruise is taken, it will prove both interesting and entertaining to hear the different broadcasting stations in the various sections of the country. There are many low-power broadcasting stations in the smaller cities that have a range of only a few miles. These stations may be picked up easily with a radio set on a cruiser, and the log book of such a cruise would show the call letters of a great many stations that the owner never before knew were in existence. Then there will always be the large stations to come booming in over the little ones at any time.

What is the best type of receiver for this work? What is the best antenna that can be erected on a small boat? Where can we locate the set?

These and many more questions at once come to the boat owner when he has decided to install a set.

First, let us consider the antenna.

Most small cruisers have short masts erected on the cabin tops; in order to give the antenna all the length possible, it would be advisable to erect a topmast —if possible, a portable topmast. This may be done by fitting either the forward or after side of the mast with what is called a "track," such as is used on sailing yachts in place of mast hoops. Once this track is in place, it is not much of a job to fit the top-

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mast in place, and by arranging a small pulley at the top of the permanent mast, the topmast may be lowered or raised at will. Side guy wires may be arranged to work with it, and the antenna itself used to act as a fore and aft guy.

The antenna should be made of stranded copper wires, so that it may be easily rolled up and stowed away. At the forward end a good sized screw eye may be secured to the stem head and the antenna may be connected direct to this, after a small porcelain cleat has been arranged to insulate it. If the boat is extremely small two wires should be used, arranged on spreaders about two feet long, with a spreader at the top of the mast and another fastened at the stern end of the awning frame. Thus the antenna will run from the stem head up to the top of the mast and down again to the after end of the awning, in a sort of inverted V.

Edwin Levick

A PORTABLE MARINE SET—

1 *Sets intended for use on small boats must be easily transported and easily set up and taken down—unless one owns a private boathouse in which to lock up valuables!*

The lead-in should be arranged so that it comes from the forward end or from the after end and not from the middle. In this way a fair-sized antenna may be put up on a small boat and the reception of long distance stations should not be difficult.

If the lead-in from the antenna comes into the cabin, it should be carefully insulated. Remember that salt water is a good conductor of electricity and unless this wire is arranged so that it puts all of the received energy where it is wanted (in the set) the receiving range will be considerably reduced. In fact the signal may be completely absorbed by damp woodwork and nothing whatever will be heard. A long porcelain tube, run through the side of the cabin, will do the trick.

The receiving set may be run from the storage battery that is already on board. A great many small cruisers have batteries for either starting the engine or for running the electric lights. However, there is one point that must be looked into carefully; if the type of vacuum tube is used that requires a storage battery, care must be used that the battery on board is not more than six volts. Some of these batteries are of the twelve-volt type. If this is the case it will be necessary to use only half of the cells in the battery. This may easily be done. There is a vent cap for each cell and therefore it will be easy to locate the first three cells. A connection may be made to the third cell and from one of the outer cells and the voltage will be correct for the ordinary vacuum tube of six volts.

If the cruiser is of medium size, it will be practical to make a receiver with a two-stage amplifier that uses a loudspeaker so that everyone on board may hear the broadcasting. The loudspeaker should be mounted on a small shelf in-

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Edwin Levick

—AS IT APPEARS INSTALLED AND IN OPERATION

2 *Many claims are made for the spiral antenna, which has its distinct uses and advantages. Just how useful it would be in a canoe in any but the most calm weather is a question. But who would venture out in a canoe in a storm, anyway?*

side of the cabin (as shown in Figure 1-B) in such a way that the bell of the horn comes out of an opening in the bulkhead. This will keep the whole set and the loudspeaker inside of the cabin, yet make the music plainly audible in the cockpit where the listeners usually sit.

If the storage battery is of the kind that is being continually charged while the engine is running, it will not be possible to use the set while the boat is in motion. However, a separate battery may be installed for this purpose, with a double-pole, double-throw switch arranged so that the batteries may be changed over for charging. If the set is used at the same time that the battery is on charge there is danger of burning out the tubes.

The type of set to build depends on the size of the boat and just how much room is available. The first set to be described is a small one, designed for a small boat, that can make use of a shore antenna.

Here compactness is the first consideration and it will be necessary to

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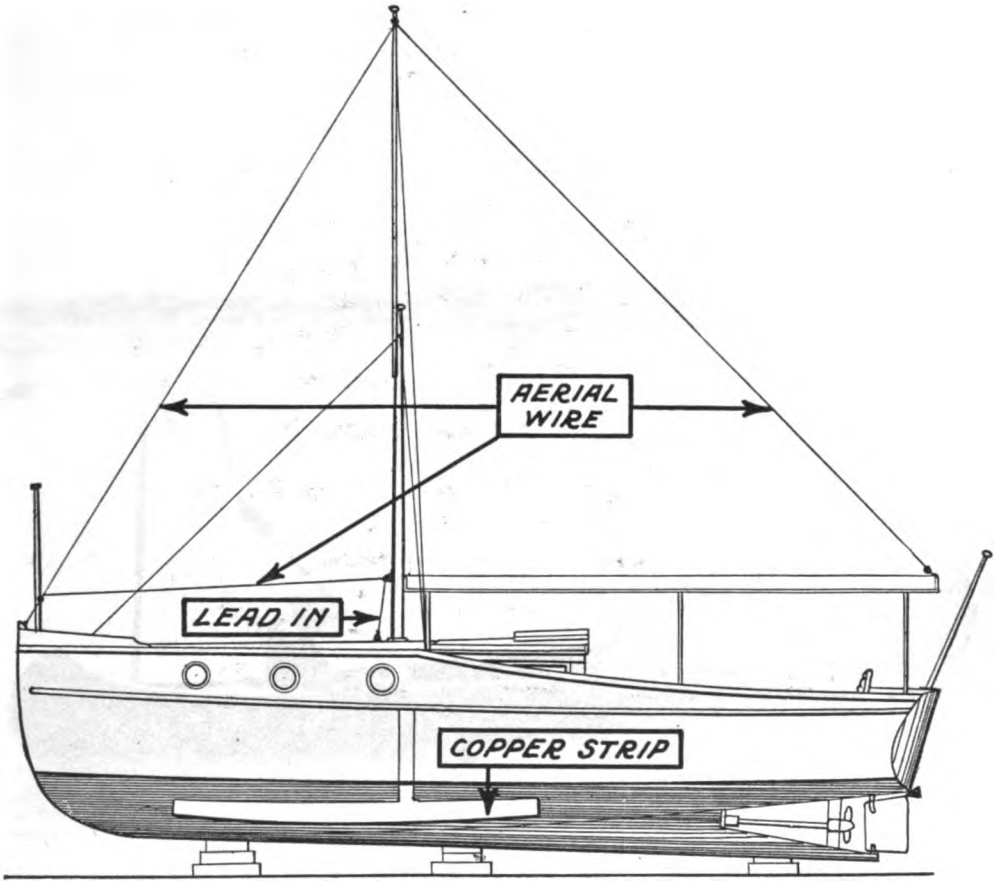

HOW TO INSTALL AN AERIAL AND A GROUND ON A YACHT

The antenna starts at the deck insulator, runs to the insulator at the bow, thence to the top of the collapsible mast, and ends up at the insulator at the rear of the awning.

use a dry-cell tube. The writer has made several of these small sets and has found them to give good satisfaction. In Figure 2, letter A indicates the primary and B the secondary coil. These coils are of the simplest construction; they consist of 13 and 35 turns respectively, wound on a composition or a cardboard tube about three and a half inches in diameter. Both windings are wound on the same tube and are spaced about a quarter of an inch apart. Be sure to see that both windings are wound in the same direction.

The secondary coil is tuned with the aid of the 23-plate variable condenser C. The grid leak and condenser is shown at D. The numeral 1 indicates the grid of the tube, 2 the plate, and the two filament leads are marked 3. The letter E is the small fixed condenser (.002 mfd.); F shows the telephones and G the rheostat. "A" and "B" are the batteries.

One advantage of this set is the fact that it may be built in its entirety within a small space. A panel only 7 inches high and 10 inches long will suffice, and with a suitable cabinet the batteries may be placed within it; the only external connections are the leads for the antenna and the ground and the cords to the receivers.

The binding posts for the antenna and the ground connections may be ar-

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ranged inside of the set in such a way that the wires leading to them are run out of the back of the set, thus doing away with all unsightly external connections.

To tune the set, merely turn on the filament and turn the dial of the variable condenser around until the loudest music is heard. A final adjustment of the rheostat may be necessary to get the best results. Remember that a dry-cell tube does not light up as brilliantly as the ordinary six-volt tube, so do not try to overload your tube; its life will be shortened considerably if it is burned too brightly.

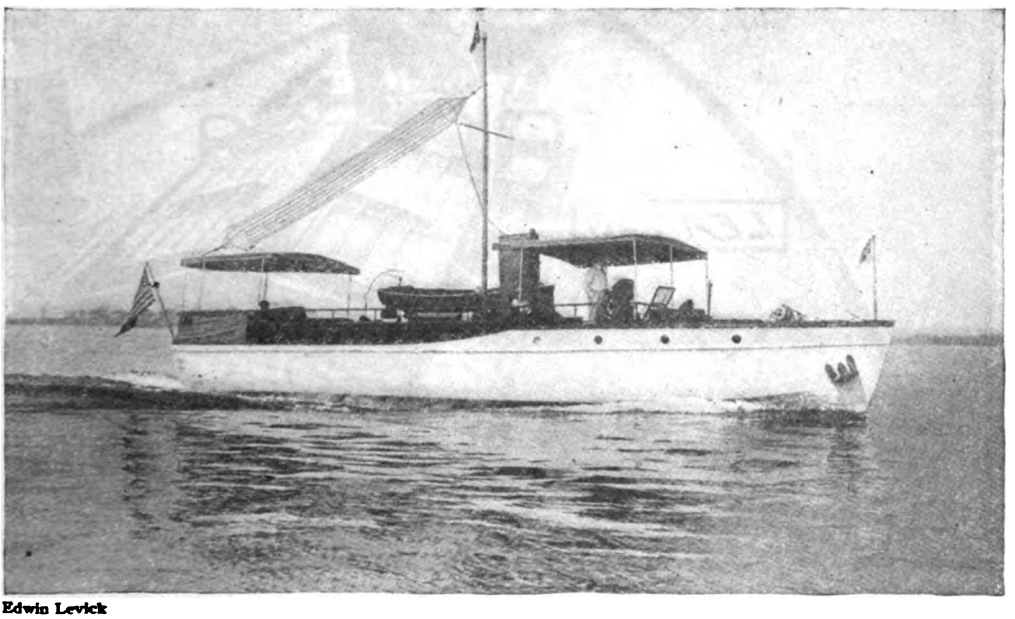
The receiving set for a canoe or an extremely small boat of any kind, in which it is not possible to erect any sort of an antenna, had better be of the radio frequency type; as such a set cannot be easily made at home, it is best to purchase outright one of the many makes of really good loop antenna receivers. One of the small types of reflex sets should be ideal for this purpose; with a small loudspeaker it should give nearly the same volume of sound that a phonograph will give. Such a set is portable and takes up little space.

The cruiser, however, may be equipped with a set that can be built entirely at home. A good regenerator with a two-stage amplifier will be suitable. The type of tuner, however, is a problem that will require some thought. Just what is wanted? The answer is compactness, simplicity and reasonable cost.

The single-circuit receiver, for several good reasons, will be eliminated at the start.

The two-variometer and variocoupler hook-up makes a fine set, but such an outfit takes up too much room. This leaves but one choice in the way of a receiving set—the three-coil honeycomb outfit. (See Figure 3.)

With such a set all-the-year-round enjoyment may be obtained, as it may be taken ashore in the winter and used in the owner's home; if it is properly built and operated it will give fine re-



Edwin Levick

A CAGE ANTENNA FOR BOTH RECEIVING AND SENDING

Efficient as this type of aerial is, it cannot be recommended for use on boats less than 50 feet in length.

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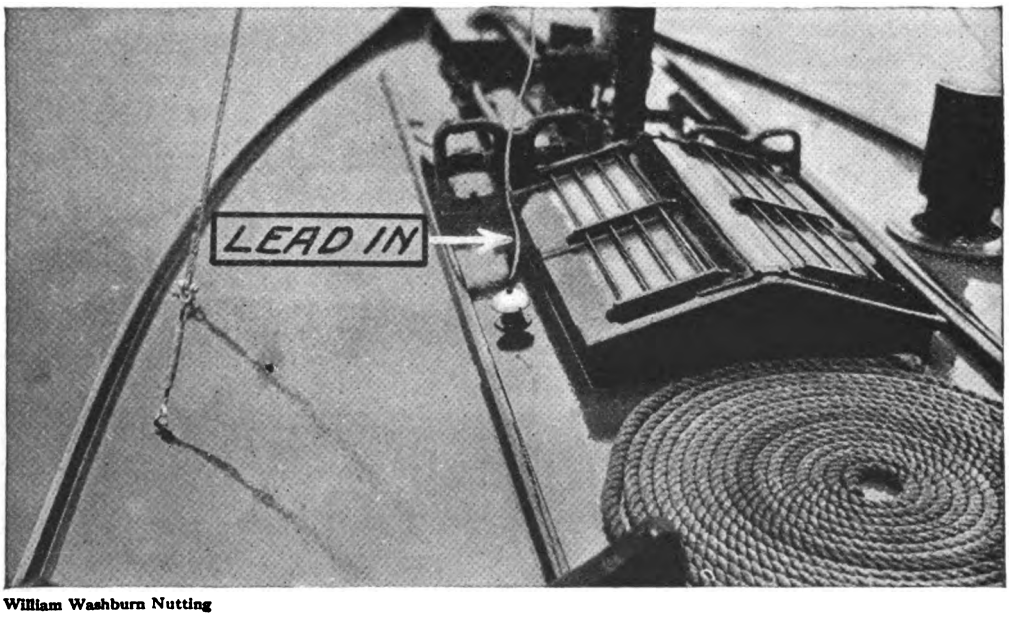
sults with good sensitivity and sharpness of tuning.

The main advantage of such a set, however, lies in the fact that it will enable the operator to tune his set to any wavelength, and if, through any legislation in the future, the broadcasting should be pushed up on a higher wavelength, the set may still be used; the only additional materials that will be required are a few of the larger-sized honeycomb coils. A number of the long wave commercial stations frequently send at a slow rate of speed, and after some practice the radio fan should be able to read at a fairly good speed. Arlington time signals and weather reports may also be picked up direct.

This set has three coils that are mounted on the outside of the panel by means of a triple-coil mounting. The coils are made in such a way that they may be plugged in and out at will, thus extending the wavelength range over wide bands. The coils are wound on a special machine for this work; owing to the peculiar construction they are called honeycomb coils. The duolateral coil is practically the same thing under a different name.

Two condensers are used in this set in order to give the finer tuning adjustments, as changing the coils gives only rough tuning. The condensers should be of the vernier type in order to get the best results; furthermore, they will give more accurate tuning and allow the operator to bring in distant stations that might ordinarily be passed over. One of these condensers is used to tune the primary circuit and the other condenser is used for the secondary. No additional tuning apparatus is necessary.

It should be remembered that inductive coupling between the coils in the triple-coil mounting is varied by swinging the coils closer together or further apart. The tendency of the beginner is to jam the three coils right up close together all of the time. This is a mistake; it will broaden out the tuning to such an extent that all



William Washburn Nutting

HOW THE LEAD-IN WIRE IS FASTENED TO THE DECK INSULATOR

The insulator has a terminal inside the cabin, where it is fastened to the antenna binding post of the receiving set.

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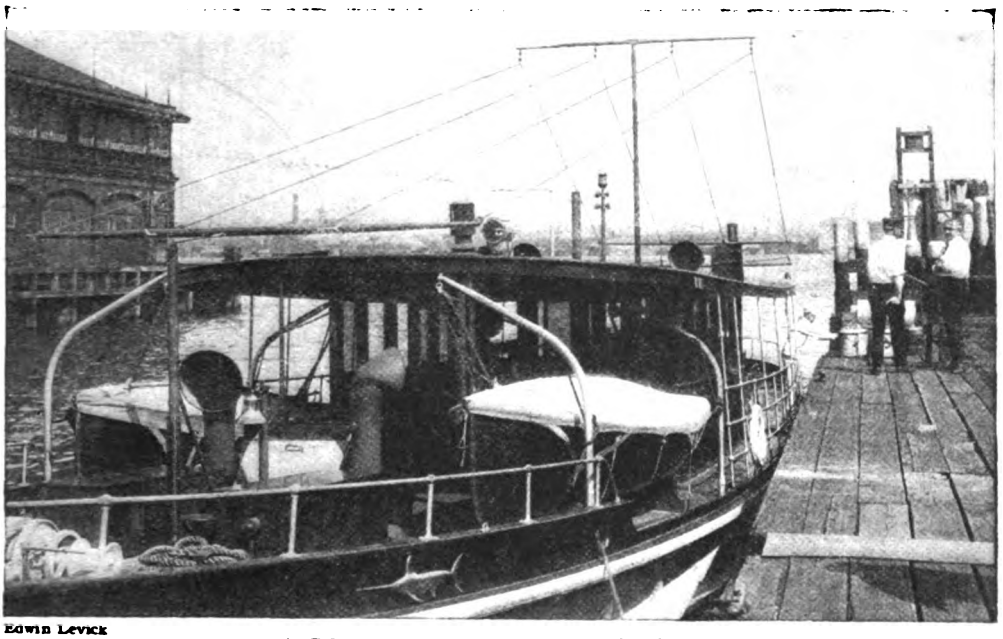

Edwin Levick

A GOOD ANTENNA FOR A CRUISER

Like the cage-type of antenna shown on page 9, this antenna is suitable for both receiving and transmitting, and is probably superior because of its higher capacity and greater length. It is arranged in the shape of an inverted V.

sorts of interference will be experienced, both from commercial and amateur stations. The coils should be carefully manipulated (swung back and forth on their hinges) so that there is quite a distance between them; the condensers should be used to bring the signals up to their maximum intensity.

The circuit is simple as is illustrated in the diagram, Figure 3. The coils are shown at the left of the drawing and are represented as A, the primary, B the secondary and C the tickler. For all ordinary broadcasting work these should be honeycomb or duolateral coils, L-50 for the primary and secondary and L-75 for the tickler. If at first the set does not function properly it will be wise to reverse the wires to the tickler.

The secondary condenser is shown at D and it should consist of 23 plates; E is the primary condenser of 43 plates, one side of which is connected to the bottom end of the primary coil and the other side to the ground binding post. Be sure to get condensers that have a good firm connection to the rotary plates, as this is the weak spot in many of the condensers that are on the market at present. F stands for the grid leak and condenser of the ordinary type, and 1 is the grid of the vacuum tubes and 2 is the plate. The two filament leads are shown at the two figures 3. H is the rheostat. A vernier rheostat might help a little at this point, if one of the highly critical tubes is used. The "A" battery may be three dry-cells connected in parallel, if the small one-and-half-volt tubes are used; if six-volt tubes are used a six-volt storage battery must be employed.

The receivers are plugged in at the points marked I and J. A double circuit jack I, is used in the detector circuit and first stage and a single circuit jack J is used in the last stage of amplification.

Two amplifying transformers (K) are used and two extra sockets and rheostats.

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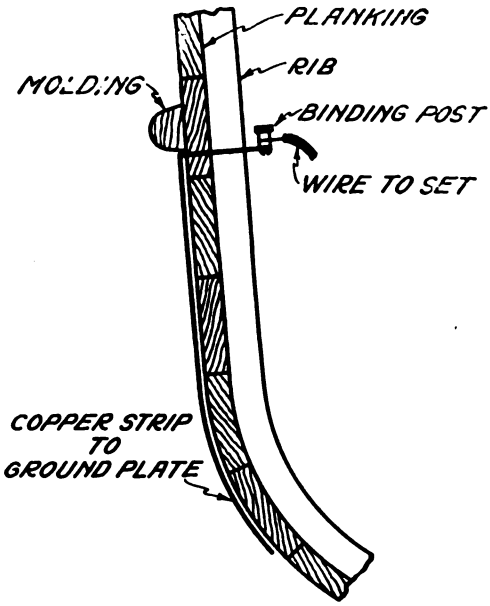
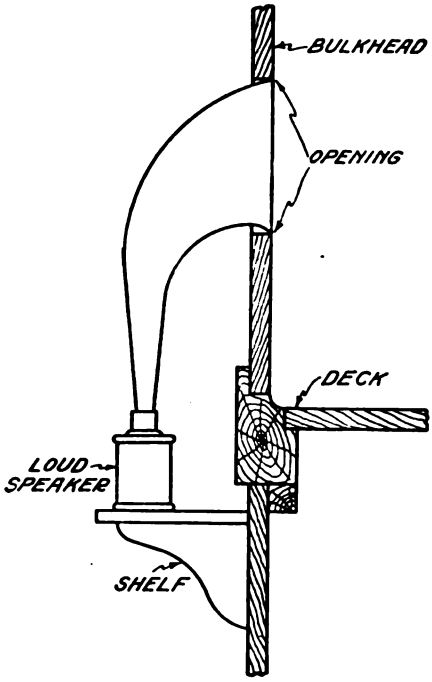


HOW THE GROUND MAY BE CONSTRUCTED

FIGURE 1A: *This diagram shows the method of fastening the copper strip to the planking and of bringing it through just beneath the molding to a binding post to which is connected the ground lead of the set.*



A NOVEL WAY OF INSTALLING A LOUDSPEAKER

FIGURE 1B: *In order that those seated in the cockpit may hear the entertainment, the instrument may be mounted on a shelf inside the cabin, with the mouth projecting out of the bulkhead.*

William Washburn Nutting

THE RECEIVING SET INSTALLED IN THE CABIN OF A SMALL YACHT

Notice the installation of the loudspeaker—which is one of several methods of using it on a boat. (Compare this arrangement with that shown above, Figure 1B.)

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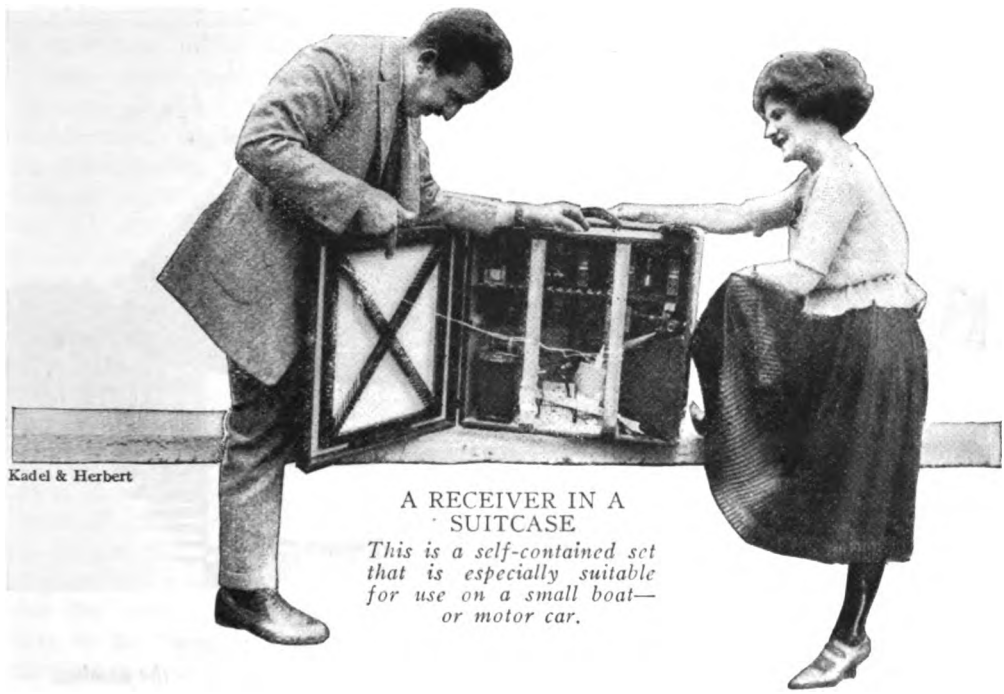

Kadel & Herbert

A RECEIVER IN A SUITCASE

This is a self-contained set that is especially suitable for use on a small boat—or motor car.

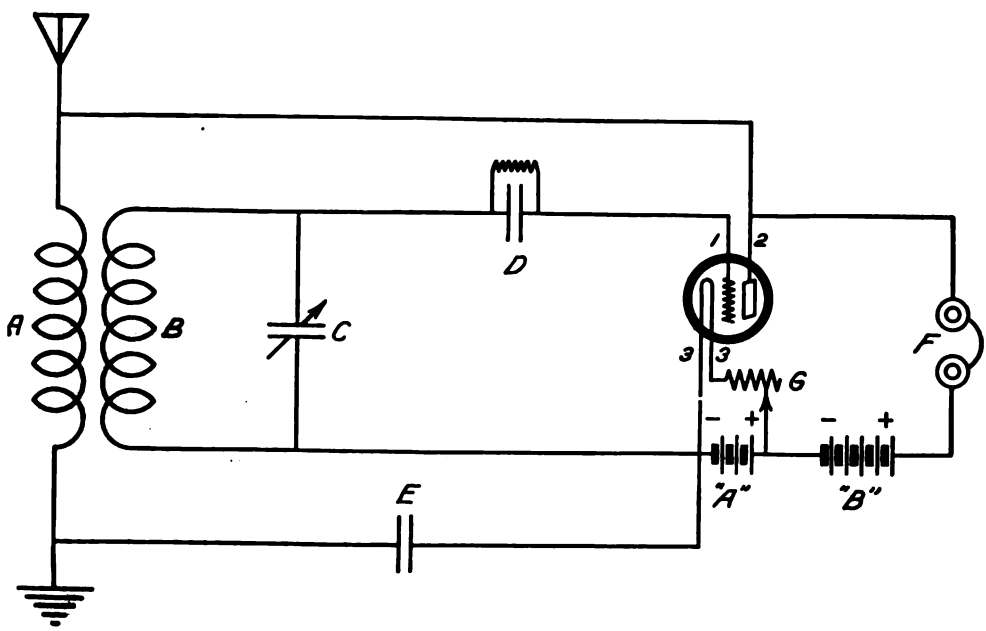

FIGURE 2: *A circuit-diagram of a single-tube receiving set that uses a shore antenna and works on dry-cells, showing the connections for the instruments.*

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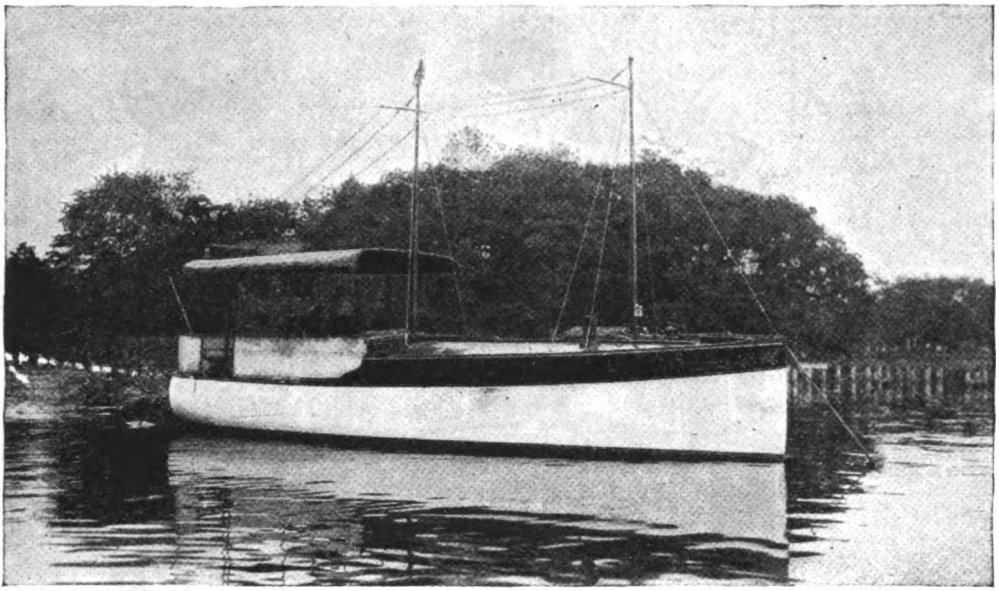
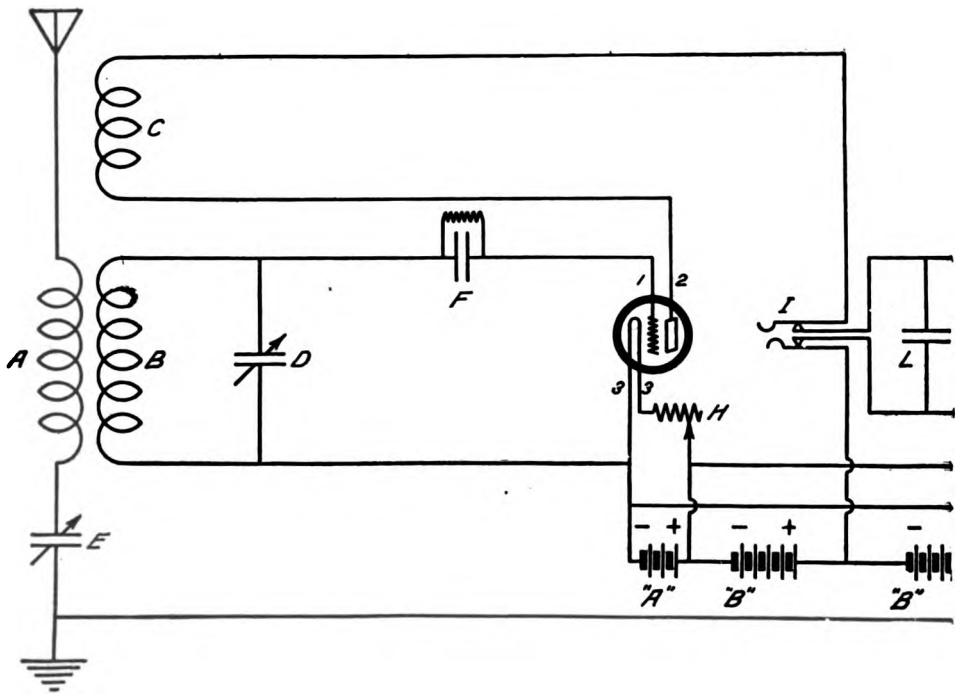


William Washburn Nutting

A THREE-WIRE ANTENNA ON A SMALL CRUISER

The wires are supported by three wooden spreaders that are fastened to the awning, the mainmast and the foremast. In this case the lead-in is taken off at the lower spreader aft.



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In any radio set the wiring should be done as neatly as possible. Try to keep the length of the wires as short as possible. Wiring that is laid out in neat angles looks pretty, but the straight-line wire, that covers the distance between two points in the shortest route, is by far the most efficient. In the amplifier, the wire from S-1 of the amplifying transformers to the grid of the tubes should be made as short as possible.

Do not use wire that is too light, and do not use wire that is too heavy. About size No. 20 will be suitable.

Another field for the marine radio set is in the houseboat. Here we have practically the same conditions as in the larger yacht on which any kind of a good set may be used. Remember that the same ground connections will have to be made, as were described in the first part of this article.

As a suggestion for the loudspeaker on this type of boat, where comfort is the first requisite, it would not be much of an undertaking to arrange the set in the main salon and have the boat wired up for numerous loudspeaker connections. A plug may be provided on the upper deck so that one of the crew can bring up the loudspeaker and plug it in whenever the owner so desires. Other plugs may be arranged below, wherever necessary, so that the loudspeaker may be moved about at will and in stormy weather none of the delicate parts will be exposed to the elements.

The antenna is a simple proposition for such a boat; it is usually installed in the same way that a shore antenna would be put up—simply a pole fore and aft with two-foot spreaders, well insulated and with a lead-in wire dropping from one end. On any boat under fifty feet in length it would be best to use two wires, but for boats longer than this one wire will be suitable.

Lightning arresters should be arranged on any boat in the same manner as in shore installations.

There is no reason why radio should not be used just as much in the summer as in the winter; in fact on the water or in a bungalow, the radio set would do a great deal to fill the hours of vacation with real enjoyment. During the summer of 1922 good reception was the rule nearly every night. Of course, during thunder storms the set should not be used on account of the static, but these storms are usually of short duration and the set may be put into operation soon after the storm is over.

Still another form of antenna for a boat might be included in this list—

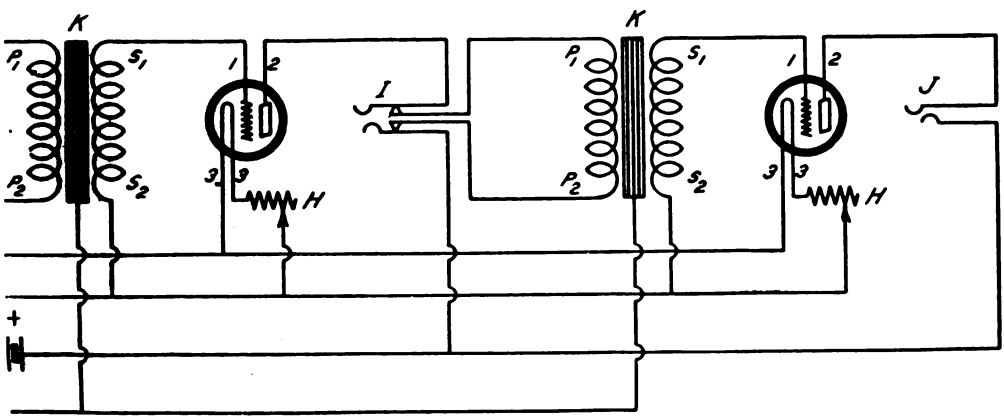

FIGURE 3: *The circuit-diagram of a triple-coil set with two stages of audio frequency amplification. This set may be used with a loudspeaker.*

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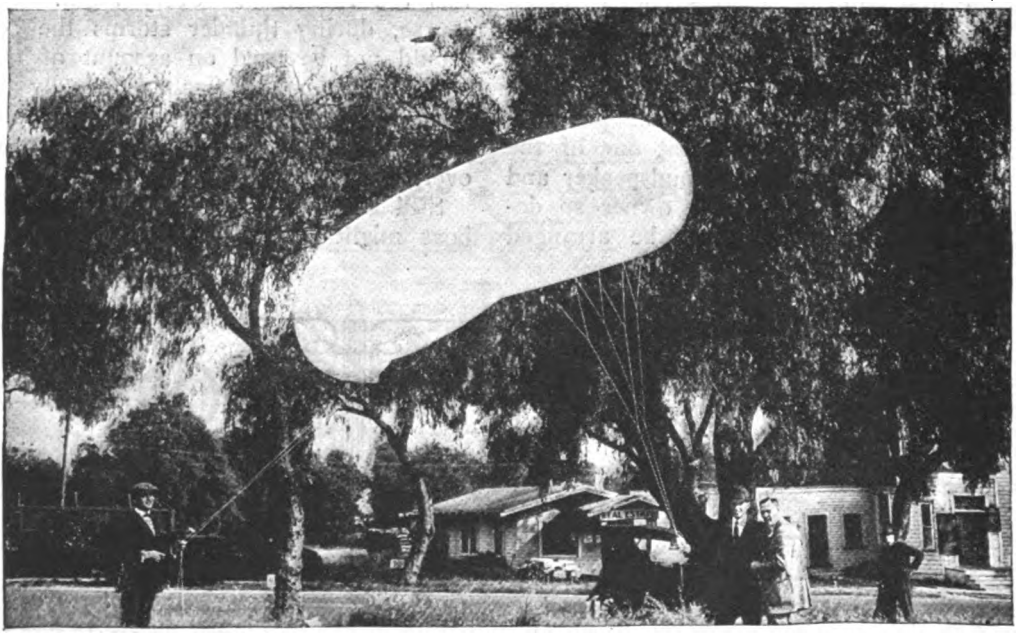
the type used successfully on the Great Lakes during the past summer.

A piece of well-insulated rubber covered wire was dragged from the stern of a moving boat and connected to the set in place of the usual antenna. Results were really astonishing; often they were even better than with the usual overhead antenna. The wire, of course, was insulated from the surrounding water; the rubber insulation did not permit any of the water to get into the wire. The end of the wire (where it had been cut off) was incased in a small glass bottle and sealed in with paraffin.

If you own a small boat or canoe, get one of the many types of radio frequency sets that are now on the market and use it with a loop, or else get a tube set that operates on a one-and-a-half-volt tube and that employs an antenna fastened from boat to shore. The small cabin cruiser may have a good set stowed away somewhere in a locker with an antenna stretched from stem to stern. The large yacht or houseboat may go the absolute limit in regard to equipment with a complete radio installation.

Some of the newer and larger yachts are equipped with sets of the finest manufacture, with licensed operators on board. Such yachts usually carry a regular commercial operator, a complete transmitting set and a sensitive receiver. The operator takes care of the tuning so that the owner and his guests may listen to the broadcasting on the after deck, and loudspeakers are installed for this purpose.

¶ *If you have a boat, no matter how small it is, equip it with radio and treat yourself and your friends to some really good music, while anchored in some snug cove for the night, or in the daytime. That is the best way to enjoy a cruise.*



A BALLOON "MAST" FOR AN ANTENNA

When Marconi made his first successful experiments in transatlantic radio about twenty years ago, he attained the necessary height for his antenna wire by attaching it to a captive balloon. R. W. Coburn and Roy Knabenshue of California believe that this is a practical idea for use today; here is shown one of the first of the small balloons they have built for this purpose.

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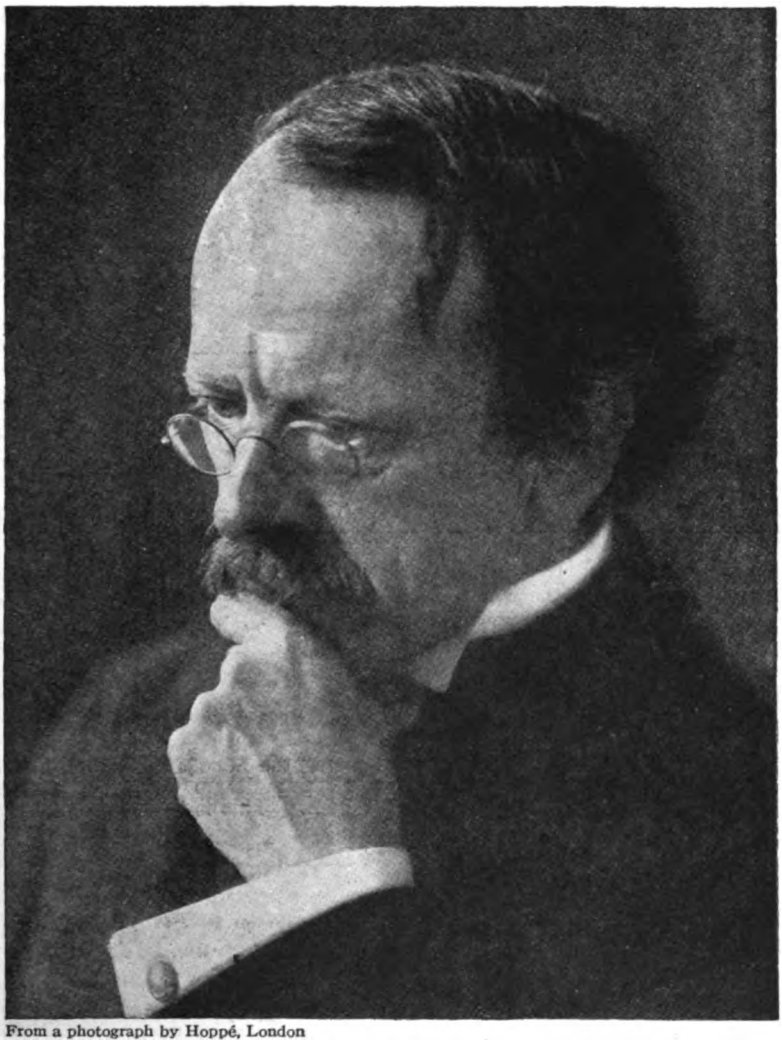

From a photograph by Hoppé, London

The Scientist Who Discovered the Electron

SIR JOSEPH J. THOMSON, *Master of Trinity College of Cambridge, England, a student of the positive rays of electricity, is not only one of the most distinguished of living physicists but more than any one scientist he discovered how atoms are built up, what matter and electricity are made of, and what are the fundamental facts that underlie both physics and chemistry. Sir Joseph delivered recently at the Franklin Institute in Philadelphia a course of lectures which were among the most important scientific events of the year. By special arrangement with the Franklin Institute, following an interview by the editors of this magazine with Sir Joseph himself,* POPULAR RADIO *will shortly publish the first of a series of articles concerning some of Sir Joseph's most recent conclusions about electrons and atoms.*

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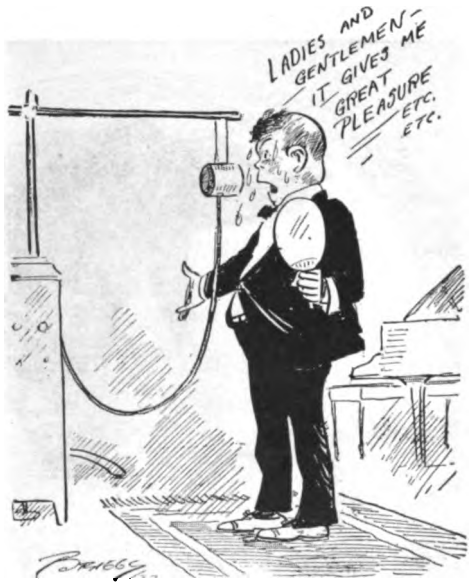

"WHEN A FELLER NEEDS A FRIEND"

"I had an uncomfortable feeling that the thing wasn't turned on; that somebody was playing a joke on me."

My Speech to a Tomato Can

When the Editor arranged to have "Briggs," the famous cartoonist, broadcast his maiden speech, he knew that POPULAR RADIO would get a frank confession of "how it feels." This is it!

By CLARE BRIGGS

SOME day, when I get around to it, I shall draw a cartoon on *what an announcer for the radio thinks about.* As he sits there night after night, introducing to a vast unseen audience famous men and women, listening to wonderful music, is his appreciation dulled? Is he no longer impressed with the marvel of sending his voice out to hundreds of thousands of listeners scattered over millions of square miles? Is it all just part of the day's work, or could a man *ever* get over the wonder and novelty of the thing?

I wonder!

Well, anyway, having talked to a radio audience myself, I am qualified to tell the world how the radio performer feels. And those of you who have been curious to know what that feeling is, need be curious no longer if you will but follow my instructions. It's very simple:

Get an old tomato can, suspend it horizontally from the end of a pump handle, and talk to it.

It feels just like that to talk to a radio audience!

A pump handle may be rather hard to locate in this age and a water spigot positively will not do. I'd suggest—let me see— tieing the garden rake across the top of the hall hat tree and hanging the tomato can on the end of that. The important thing is to get the can at about the level of your face—that is the purpose of the suspension.

Of course, you have to imagine that half a million people are listening to what you say, but that will be no harder than it was for me to convince myself that

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anyone heard me, aside from a dozen or more people in the room, when I talked into WJZ's scientific tomato can at the Westinghouse plant in Newark.

I had a most uncomfortable feeling that the thing wasn't turned on; that someone was playing a joke on me.

In fact I didn't realize what happened until two days later when I began to get letters from people who had heard me hundreds of miles away. One friend had heard me at a summer camp up on the coast of Maine. The full weight of responsibility which had rested on my shoulders those few minutes that I "had the air" then first occurred to me.

It's an *awful* responsibility, this talking over the radio. Occasionally, when I have worn threadbare all the old excuses about a previous engagement, the pressure of business and the like, I have to address a gathering of some kind. You can always tell when your stuff isn't going over. An old-time audience is not without means of self protection. It can shuffle feet and chairs, cough and blow noses, and drop silverware (if it's a banquet). I flatter myself that I have never had an audience actually get up and walk out on me, nor have I ever been forcibly ejected from the premises.

But a radio audience has no comeback.

From a photograph made for POPULAR RADIO

"WHAT A BROADCASTER THINKS ABOUT"

"Not the least disconcerting forethought was that my family would be grouped around the set at home, snickering at Dad's homely utterances."

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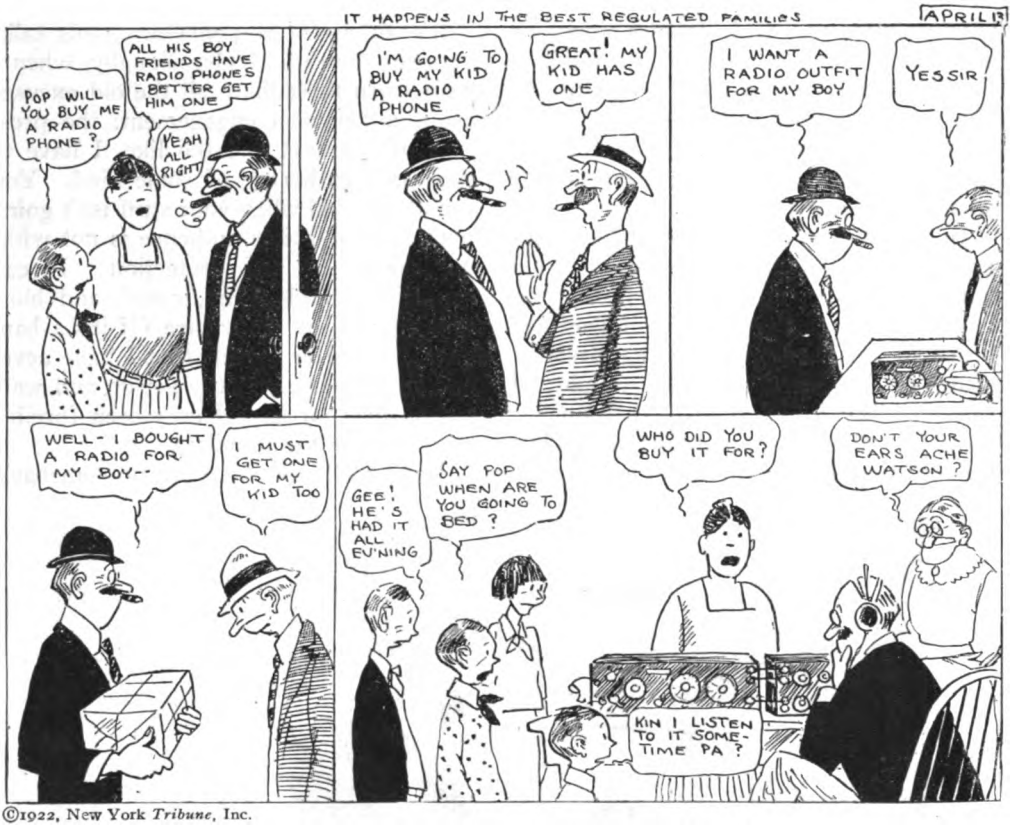
IT HAPPENS IN THE BEST REGULATED FAMILIES
APRIL 1?
POP WILL YOU BUY ME A RADIO PHONE ?
ALL HIS BOY FRIENDS HAVE RADIO PHONES - BETTER GET HIM ONE
YEAH ALL RIGHT
I'M GOING TO BUY MY KID A RADIO PHONE
GREAT! MY KID HAS ONE
I WANT A RADIO OUTFIT FOR MY BOY
YESSIR
WELL - I BOUGHT A RADIO FOR MY BOY--
I MUST GET ONE FOR MY KID TOO
GEE! HE'S HAD IT ALL EV'NING
SAY POP WHEN ARE YOU GOING TO BED ?
WHO DID YOU BUY IT FOR?
DON'T YOUR EARS ACHE WATSON ?
KIN I LISTEN TO IT SOME-TIME PA ?

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"IT HAPPENS IN THE BEST REGULATED FAMILIES"

"I have a notion that I ought not to make cartoons about any subject of which I have not first-hand knowledge," the author admits. So he bought a set—and drew this record of the results.

They've got to take what you hand them, or hang up. I suppose there is nothing so good goes over the radio but that a few listeners hang up, and nothing so bad but that a few simple souls continue to listen in. If there were only some kind of a meter to hang up before the radio performer which showed exactly how many persons are listening in! In justice to the great listening public, I think the inventors ought to get busy on such a device. Give the radio audience a comeback.

Now the radio performer can only imagine, as he steps up to the tomato can, that he hears the clatter of thousands of radio receivers being "hung up."

That tomato can transmitter is an austere and unencouraging device. You can't even be sure the darned thing is working, and if it is, whether the audience (for which it is a single, sensitive ear) is smiling or gnashing its teeth. The poor performer can only sweat blood and imagine the worst.

I've been asked if I was nervous. Gosh, yes! If ever a feller needed a friend, I did then. I had been working myself up into a state of nervous excitement for a week before. What if my voice or delivery didn't "take," just as some good stage actors don't film well in the movies. I made up my mind that the razz-berry crop would be good this year.

I knew a little bit about radio before I went to WJZ. In fact that's one of the things that made me nervous—I knew *such* a little bit. I am not of a mechanical turn of mind. The one mechanical stunt at which I possess some genius is shutting off the alarm clock in the morn-

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ing without having to wake myself up.

But I have a notion that I ought not make cartoons about any subject of which I have not first-hand knowledge. I also have a theory that the best cartoons are those which depict the everyday happenings in the average home. Radio has suddenly become an intimate part of the home life of the country. So, as a mere matter of business precaution, I had a radio set installed. When I was invited to speak from WJZ I felt that I really ought to take the opportunity to round out my radio experience. Immediately after accepting I regretted my business prudence in installing the set in my home. For not the least disconcerting forethought was that my family would be grouped around that home set, snickering as Dad's homely utterances came to their ears *via* nothing. (Nothing is technically correct, I believe. Dr. Steinmetz says there is no ether, and ether from ether leaves nothing.)

You may well imagine, then, the feelings of curiosity, expectancy and foreboding with which I journeyed to the Westinghouse plant. I suppose all radio fans have wondered what the inside of the studio looks like, what kind of a chap the announcer is and whether he wears a mustache. I'll settle the most important point first; he doesn't.

I was wrong about the studio, too. It looks like a studio—nothing more. There was no complicated electrical apparatus in sight—just a couple of pianos, several phonographs, at one end of the room a library table, divans and chairs grouped about a big fireplace. The only mysterious thing in sight was the pump-handle-tomato-can apparatus and beside it a cabinet shaped like a phonograph which contains some of the electrical apparatus.

I arrived a good hour before my scheduled talk, but already several people were present and the announcer (I recognized his voice at once) was repeating baseball scores into the tomato can. It was a hot summer evening and those in the studio had laid aside all unnecessary clothing, giving the gathering a most informal aspect. Pretty soon the perspiring man in the chair next to me, without coat or collar, was introduced to the tomato can as a famous tenor. The practical appearing young person in the next chair, who might have been someone's stenographer, turned out to be a Spanish prima-donna!

One after another the tenor, the prima donna and a jazz band did their bit. Then I approached the tomato can for my turn. And what do you suppose I was thinking of?

There flashed into my mind the almost forgotten incident of the first time I ever talked into a telephone. I was five years old and wise enough to let my elders know before they placed the receiver to my skeptical ears, that they couldn't fool me into believing that I could actually speak to and hear someone a mile away!

I felt again as though someone were trying to "kid" me; that I was the victim of some kind of a hoax. Even here, inside a real broadcasting station and listening first-hand to one of the concerts which I had heard over my radio set, it was hard to believe these sounds got beyond the four walls of that room.

* * *

Up on the roof.

The stars are shining and the wires of the big antenna are silhouetted against the moon. The air is perfectly still; not a sound from the wires or a flash of sparks; not a sign that down below a singer is singing and that out in the night thousands of people are listening to her song. Uncanny!

* * *

Wonder what an announcer thinks about?

To prepare himself for his work as a poet, Gelett Burgess graduated from the Massachusetts Institute of Technology as a Civil Engineer—and then became a humorist! His experience in both roles was called upon when he put up his radio set. Just what happened is the subject of an article by him to appear shortly in POPULAR RADIO.

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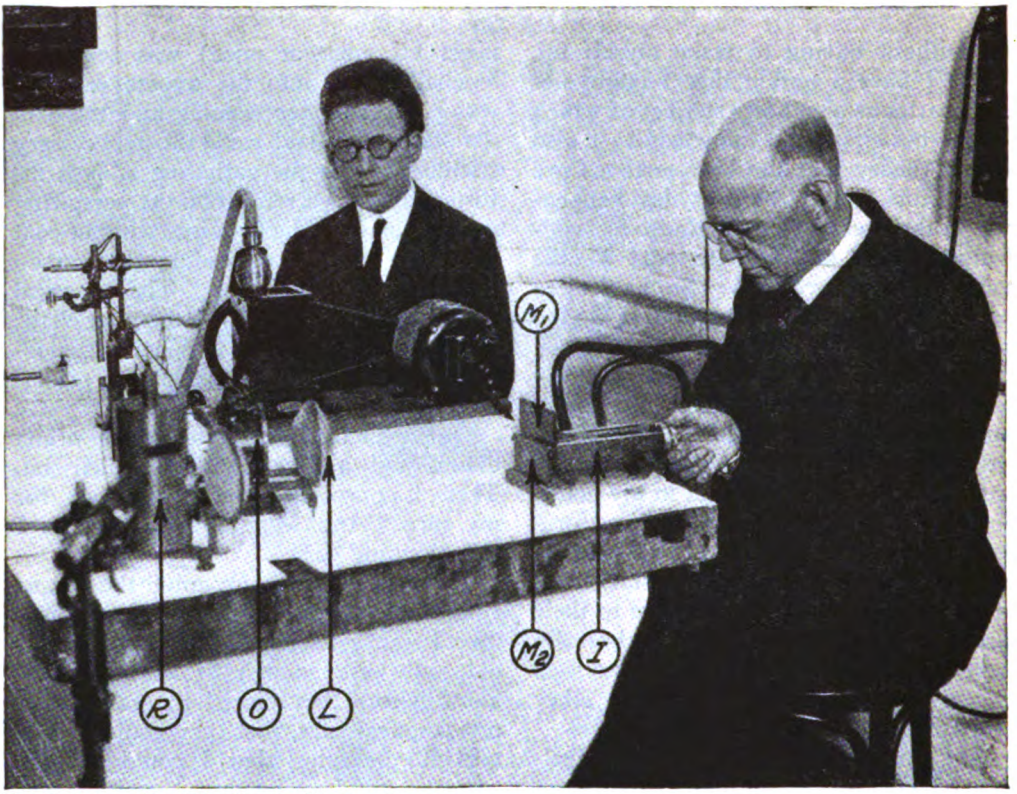

From a photograph made for POPULAR RADIO

SENDING AND RECEIVING RADIO WAVES 1/100TH OF AN INCH LONG

FIGURE 1: *At the right is Dr. Nichols, formerly president of Dartmouth College and director of the laboratory of pure science at the Nela Laboratories of Cleveland, and his associate, Dr. J. D. Tear. O shows the transmitter, R the receiver, L the condensing lens, and M_1 and M_2 the reflecting mirrors of the wavemeter I.*

The SHORTEST RADIO WAVES

Ever Produced by Man

In this remarkable article, which constitutes a real and valuable addition to the literature of science, the author describes in specific detail and for the first time his experiments with wave impluses so short that they span at last the gap between heat waves and radio waves.

By ERNEST FOX NICHOLS, D. Sc., LL.D.

THERE is no more fascinating chapter in the whole history of science than that dealing with the evolution of the various theories of light and the progress of our experimental knowledge with which these theories must square.

For nearly three hundred years there was strife among physicists—"philosophers" they were then called—as to whether light was due to countless myriads of minute imponderable corpuscles shot out along straight lines in every direction from a source of light, or whether light was an orderly wave motion spreading out radially in all directions in a universal imponderable medium called the ether.

Young's discovery of the interference

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of two beams of light made in the first year of the last century was a decisive experiment in favor of the wave theory and would doubtless have convinced all scientists had it not been for the very great authority of Sir Isaac Newton which had come down through a century and a half. Newton in his day was unfortunately an advocate of the corpuscular theory. What was known of light at that time seemed more easily explained by corpuscles than waves. Newton was beyond question one of the greatest and most progressive thinkers of all time, and had he been alive would have been among the first to recognize the convincing evidence of Young's experiment. But Newton dead proved a most formidable obstacle to progress.

Young not only proved the wave theory but actually measured the wavelengths of light of different colors showing a progressive increase as we go from violet through blue, green, and yellow to the extreme red. Thus the wavelength of yellow light situated about midway in the orderly spaced band of color which we call the normal spectrum is approximately 1/50,000th of an inch. From this time on to the middle of the century, increasing and more convincing evidence of the wave theory slowly accumulated until Foucault found the velocity of light in water less than in air by an amount in exact accordance with the requirement of the wave theory, while the corpuscular theory required just the reverse, i. e., a greater velocity in water than air.

Thus the wave theory was finally and firmly established.

Fifteen years later, Maxwell proposed a new theory concerning the nature of light waves which he based on Faraday's experiments. Maxwell's theory at the time it was proposed proved as abstruse and baffling for the physicists of his day as we find Einstein's generalized theory of relativity in ours. In fact, Maxwell was the Einstein of his generation and succeeded in puzzling everybody. Maxwell's theory asserted that light was an electric wave disturbance in the ether caused by astoundingly rapid vibrations of electric charges in the source of light. One of the chief difficulties in believing that light waves were electric waves was that in those days nobody had any electric waves to compare them with nor any indication that electric waves were possible.

In the next decade the Berlin Academy of Sciences became interested in Maxwell's theory and offered a prize to anyone who would give experimental proof of its fundamental assumption. Not long after this prize was offered, Von Helmholtz called the attention of one of his most promising students to it. That student was Heinrich Hertz who later not only obtained electric waves some two feet long in the laboratory but went further and performed with them a number of experiments demonstrating that these waves, like light, were reflected from surfaces, bent from their course by prisms, and that they traveled through space with the velocity of light.

Hertz's successors worked in two different directions. Righi, the Italian, and a number of other physicists worked toward shorter and shorter electric waves and repeated with them more and more of the classical experiments with light. Sir Oliver Lodge, Guglielmo Marconi, a brilliant young Italian experimenter, and others were inspired by the idea of making electric waves a means of signalling and communication. They worked toward longer and longer waves because long waves carry further and are not so easily scattered by obstacles. As we know, Marconi won in the long-wave contest and from his success we now have radio telegraphy, and with the advent of the vacuum tube, we have the greater marvel of radio telephony. Thus Hertz worked indefatigably to discover electric waves in order to prove that Maxwell was right,

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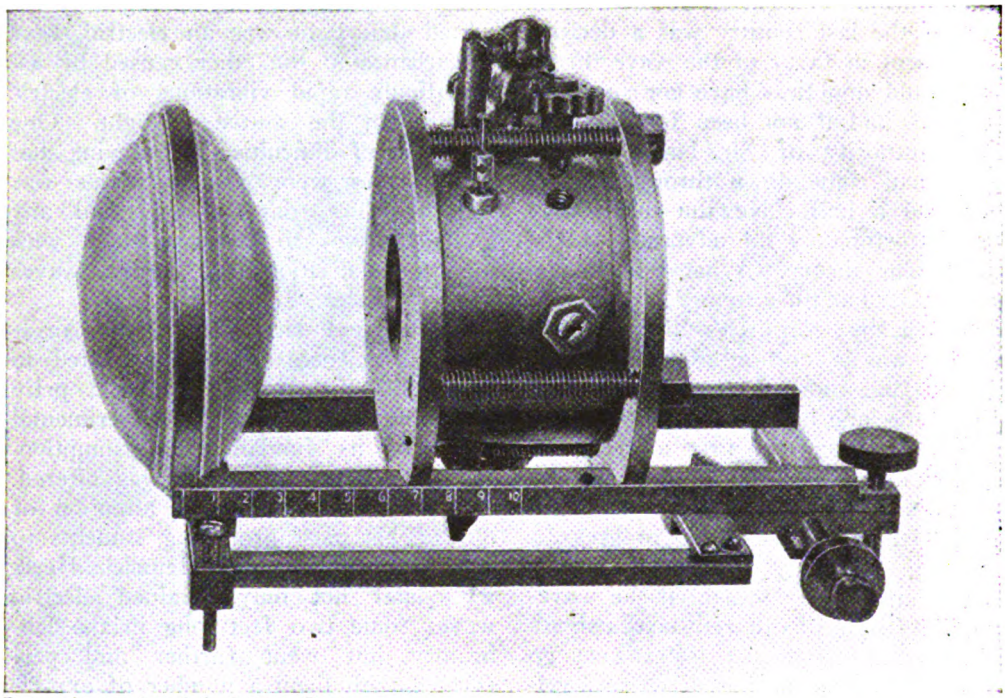

From a photograph made for POPULAR RADIO

THE TRANSMITTER UNIT FOR PRODUCING MICROSCOPIC WAVES

FIGURE 2: *This is the delicate machine for sending out the new waves. Notice the concentrating lens of paraffin which is brought into proper focus by rotating the small knob at the lower right hand portion of the instrument.*

that light waves *were* electric waves. His discovery with its consequences is but one of an accumulating number of instances in which astoundingly practical results have followed directly from the most abstruse workings of the scientific imagination.

Alongside of the discovery and development of electric waves, great progress was being made in the investigation of light and heat waves. Explorers pushing out into the dark spectrum below the longest visible red waves had extended the known region to a wavelength of about 1/10,000th of an inch, or five times the wavelength of yellow light. At this point our illustrious countryman, Professor Langley, began his labors in 1883 and extended the known wavelength region fourfold. Fourteen years later a new method for sifting out and isolating the long wave radiation from the total output of a light source such as a candle flame or a Welsbach gas mantle was discovered by Rubens and Nichols. This method led to an extension toward long waves of more than ten times Langley's outer limit. Another twofold extension was accomplished by a further advance in method due to Rubens and Wood, and finally in 1911 heat waves 1/75 of an inch in length had been successfully isolated, measured, and their properties studied. But there was still an unbridged gulf between the shortest electric waves and the longest heat waves, for the followers of Hertz and Righi had been stopped in their progress toward shorter waves at waves about 1/3 of an inch in length.

In some experiments now in progress at the Nela Research Laboratories at Cleveland, Dr. J. D. Tear and I, by the devising of new instruments and methods of experimentation, have suc-

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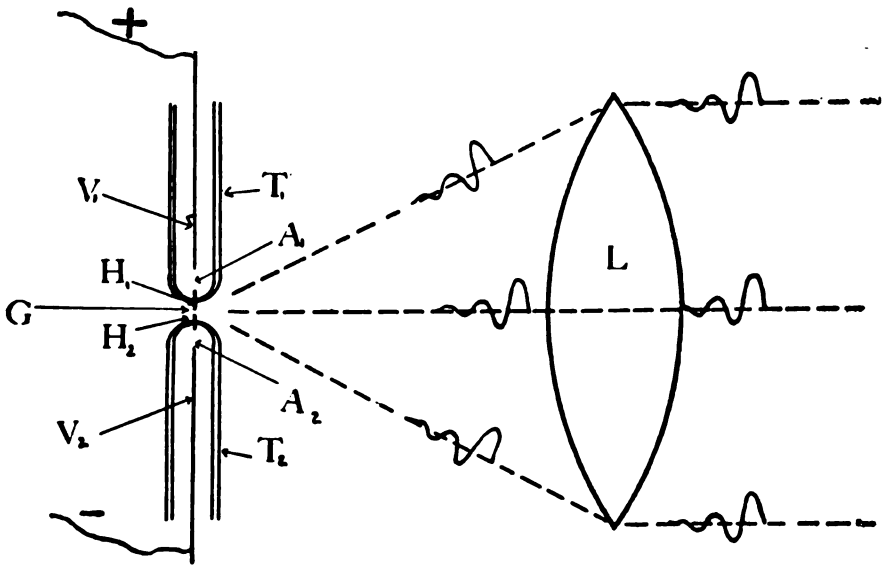
ceeded in generating and working with electric waves as short as 1/100th of an inch.

Stripped of all accessories and reduced to its essentials, the apparatus used appears in Figure 1. O is the sender unit (better seen in Figure 2). It consists of an oscillator box with necessary adjustments and a paraffin condensing lens. I is a reflection interferometer or wavemeter and R the receiver, with its condensing lens of paraffin.

Figure 3 is a diagram showing the essential parts of the oscillator in which H_1, H_2 represent two very small cylinders of tungsten separated at the middle by a very short spark gap G, the whole submerged in kerosene. These tungsten cylinders sealed in the thin closed ends of the glass tubes T_1, T_2 form a Hertzian doublet, which serves as the oscillator or wave source. The doublet is energized by charges communicated to it by the high potential leads V_1, V_2 from an induction coil. Charges leak across air gaps A_1, A_2 until H_1, H_2 are charged to a sufficient potential difference to break down the kerosene insulation in the spark gap G, when a spark passes, and an oscillating discharge of short duration ensues causing the emission of a short-wave train such as indicated in the diagram. The wavelength of the emitted radiation depends on the dimensions and mounting of the tungsten cylinders H_1, H_2. For the shortest waves obtained the cylinders were 1/250th of an inch in both diameter and length.

The divergent radiation from the oscillator is gathered into a kind of searchlight beam by the paraffin lens L, and, after reflection from the wave meter I, Figure 1, is picked up by a similar lens and brought to a focus on the sensitive surfaces of the suspended system inside the receiver case R. This receiver is of new design and depends on the following principles for its operation:

(1) Whenever electric waves fall on the surface of a conductor, they cause weak oscillating currents of the same frequency in the surface layers of the conductor. Due to the resistance of the conductor, these currents are converted



HOW THE OSCILLATOR WORKS

FIGURE 3: *The transmitter is really an extremely small adaptation of the famous Hertz oscillator. The ingenious method of exciting the oscillator is described in the text on this page.*

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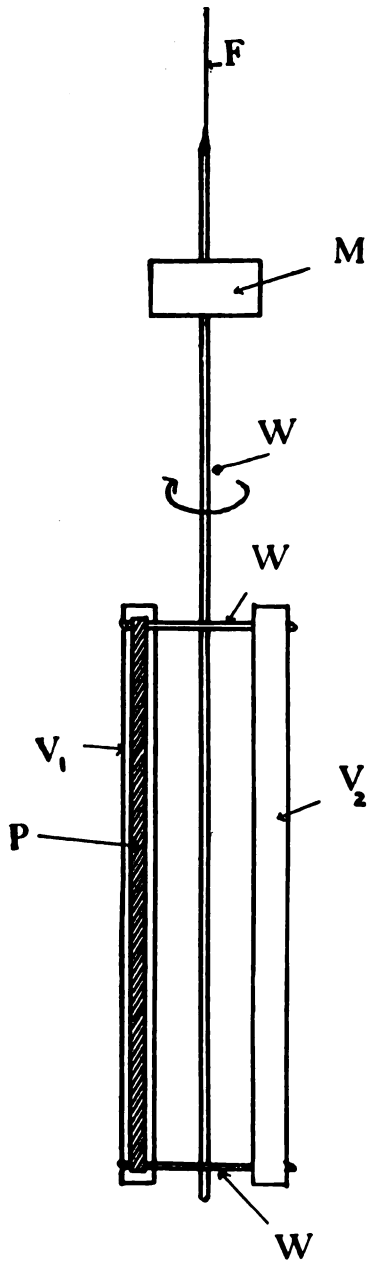

THE RECEIVER SUSPENSION
(Greatly enlarged)

FIGURE 4: *This part of the receiver, which is suspended by a quartz fiber, is an ultra sensitive detector and depends on the discovery of Sir William Crookes, that a slightly warmed surface in a partial vacuum suffers a small repulsive force, for its operation.*

into heat, and the conductor is very slightly warmed.

(2) The most sensitive means known for measuring small differences of temperature was discovered by the late Sir William Crookes who found that a slightly warmed surface in a partial vacuum suffers a small repulsive force.

With these two principles in mind the construction of the receiver suspension shown diagrammatically in Figure 4 will be easily understood. The skeleton of the system is formed of very thin whips of drawn glass W. The central axis is suspended from the top of the receiver case R, (Figure 1) by a very fine quartz fiber F. The suspension is thus free to turn but its turning is faintly resisted by the twisting of the fiber. V_1 and V_2 are small thin strips of mica attached to the cross arms. Just in front of V_1 and just behind V_2 is a still narrower mica strip thinly coated by a deposit of metallic platinum P. When electric waves fall on this system, the strips P, are warmed and the Crookes force tends to rotate the suspension against the torsion of the quartz fiber. Under properly controlled conditions, experiment has shown that the angle through which the quartz fiber is twisted is proportional to the intensity of the electric waves falling on the receiving surfaces. Just to the left of the receiver R in Figure 1 is a telescope by which the rotation of the suspension is read in the mirror M seen through a small window in the receiver case. The weight of this suspended system complete is less than a milligram or less than one thirty-thousandth of an ounce, and the temperature differences measured by the rotation of the system were certainly smaller than one ten millionth of a degree.

The wavemeter I, (Figure 1) makes use of the phenomenon of interference for wavelength measurements. The beam of radiation from the sender falls in equal parts on the two parallel mirrors M_1, M_2. When M_1 is slightly be-

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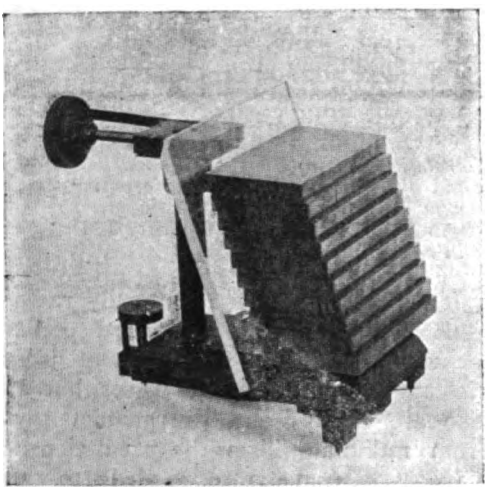
hind M_2 as shown, a wave train reflected from the upper mirror has a longer path to follow from sender to receiver than the same train reflected by the lower mirror, and hence it is delayed and when the two halves of the beam are reunited at the receiver, the separated wave trains may no longer match. By varying the distance by which the plane of the mirror M_1 is behind that of M_2 wave crests in one beam can be made to fall on the earlier wave crests of the other, and thus the two beams reinforce each other. On the other hand, wave crests of one can be brought together with the wave troughs of the other, and the two made to weaken each other. Observed positions of the mirror M_1 for reinforcements and neutralizations thus give a direct means for measuring the wavelength of the radiation.

As this wavemeter tells little concerning the wave form, a whole new wavemeter was devised. This instrument, shown in Figure 5, is in the form of a staircase made of a pile of eight exactly equal brass blocks. The back corners of the blocks rest against a slanting plate of glass the tilt of which and consequently the width of tread of the steps can be regulated and measured by a micrometer screw seen at the top. The way a single wave-train from the sender is divided up after reflection from the risers of the steps is shown diagrammatically in Figure 6, B. A shows the outline of the steps, and C is the wave form obtained when the short individual wave trains are brought together again at the receiver. By varying the width of the steps, this instrument gives a complete analysis of the wave trains showing both length and form.

The simplicity of the principles involved in these experiments and the homely character of the apparatus used may easily conceal the almost vanishing smallness of the effects measured and the great experimental difficulties which had to be overcome.

With the instruments and methods indicated we have not only artificially manufactured and measured electric waves 1/100th of an inch long but have used our electric wave receiver to de-



From a photograph made for POPULAR RADIO

THE NEW ECHELON INTERFEROMETER AND ANALYZER

FIGURE 5: *The special instrument that has been devised in the experimental laboratory for the special purpose of studying and measuring the new wave.*

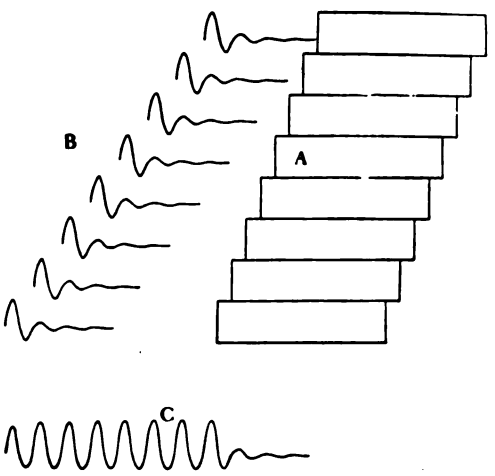


DIAGRAM ILLUSTRATING HOW THE ANALYZER WORKS

FIGURE 6: *The analyzer A breaks up a single wave front into separate wave trains B. The wave form obtained by re-combining the trains is shown at C.*

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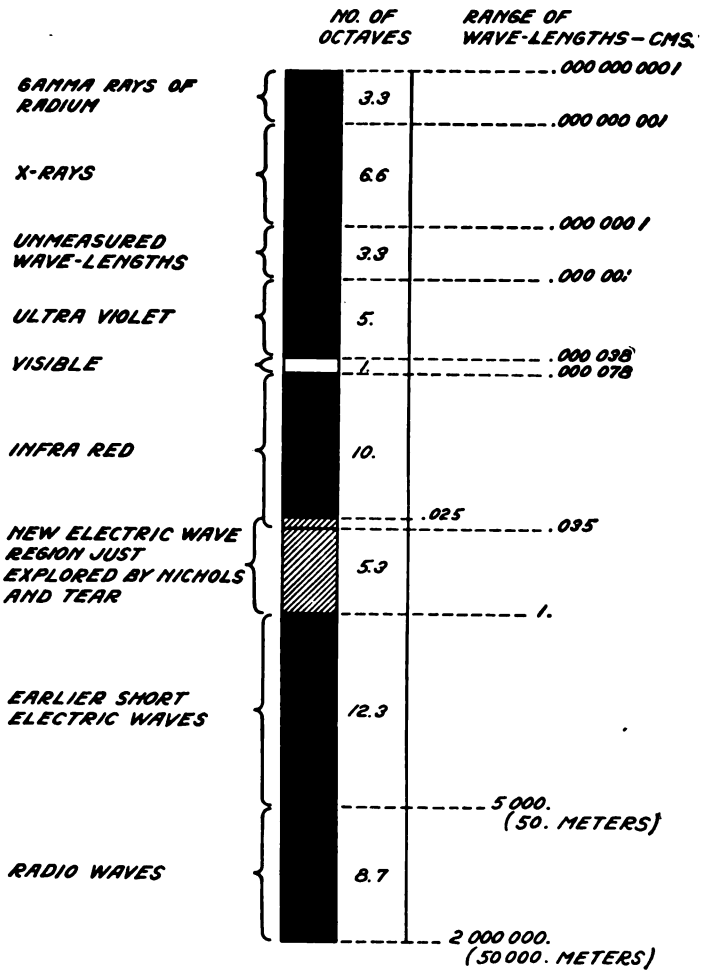

THE COMPLETE ELECTRIC WAVE SPECTRUM
(Plotted in octaves)

FIGURE 7: *The chart shows the wavelength relations and names of the various spectral regions. Notice how narrow is the band of visible light, which affects our human vision; this is shown in white. The new band of waves (shown in gray) links up the complete spectrum from the gamma rays of radium to the enormous waves employed in radio.*

tect and remeasure the 1/75 of an inch heat waves obtained from hot bodies. Thus, for the first time, waves from hot bodies and artificially generated electric waves of the same length have been obtained, compared, and found identical in character. This experiment then supplies the last link in a long chain of experimental evidence connecting light with electric waves and furnishes a final proof of Maxwell's electromagnetic theory of light.

It is finally clear that not only radiations emitted by highly heated bodies including infra red, visible, and ultra violet waves are electric waves but so also are X-rays and the gamma rays from radium. Thus the true electric wave spectrum is expanded to an enormous extent for a twenty thousand meter radio wave is twenty million billion times as long as a short gamma wave.

Of the many new things thus revealed

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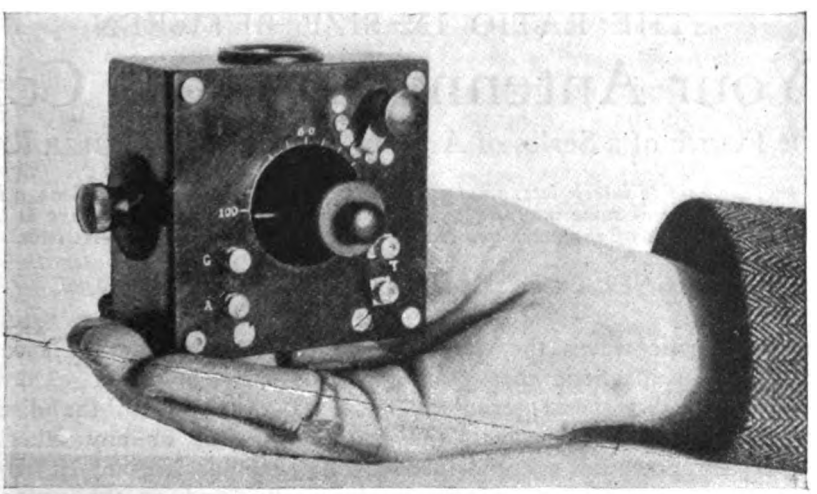
none is more surprising than the very narrow limitations of the eye in perceiving electric waves as light. Its entire range from furthest violet to deepest red is only from a wavelength of fifteen millionths of an inch to one of thirty-one millionths of an inch. It is not possible to show such small detail and such vast extent as is embodied in the electric wave spectrum by any chart laid out in simple proportions, for if we represented the length of the visible spectrum by a quarter inch space, then the whole ultra violet, X-ray, and gamma ray spectra are crowded into another quarter inch space at the left, and on the right the infra red spectrum reaches out to the longer electric waves which extend to long radio waves at a distance of 100,000 miles away—surely an unwieldly chart!

The electric wave spectrum can be manageably mapped, however, if we lay it out on a chart by octaves like the keyboard of a piano, remembering that the wavelength of the sound of the first C above middle C has a wavelength one-half that of middle C, and that the first C below middle C has a wavelength which is twice as long as middle C.

In Figure 7 such a chart of the electric wave spectrum is shown. On the left are the historic names of the different regions of the spectrum, and braces are attached to show their extent on the black strip representing the spectrum itself. Beyond, the number of octaves of wavelengths is shown for each region, and furthest to the right the wavelengths corresponding to the approximate regional boundaries are given in centimeters. On this chart the length of the visible spectrum becomes our measuring rod for it is very nearly an octave in extent, a single octave out of the more than fifty-five octaves shown on the electric wave spectrum in the present chart.

With the chart before us, it is also interesting to note that we get ultra violet, visible, and infra red waves from heated bodies but not X-rays, gamma rays, nor what used to be called electric waves. Electric pulses or partial waves we get from electric disturbances in the atmosphere called "static," and gamma rays are of natural origin in the disintegration of radioactive substances.



International

IS THIS THE SMALLEST REGENERATIVE SET IN THE WORLD?

Although this miniature set measures only 3½ by 3¼ inches in size and is literally small enough to fit in the palm of your hand, it is not only a vacuum tube set but it employs a regenerative circuit. It has picked up amateur sending over a distance of 800 miles. It was built by Roslyn Russel, a Niagara Falls amateur.

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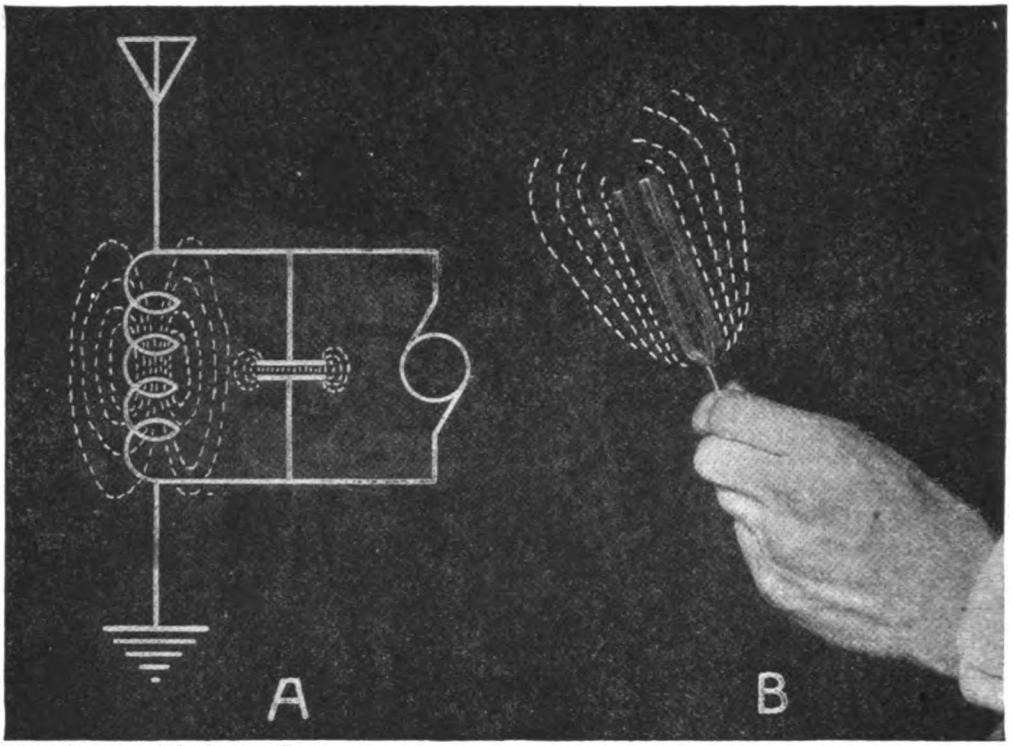

From a diagram made for POPULAR RADIO

THE SIMILARITY BETWEEN THE VIBRATIONS OF AN ELECTRICAL CIRCUIT AND OF A TUNING FORK

In case B the fork is set into vibration by striking against some rigid object and sound waves are given off. In case A, the oscillatory antenna circuit is set into electrical vibration by an impulse from the generator (shown as a circle), and electric waves are propagated. In both cases the energy alternates from a static form to a kinetic form during each oscillation.

THE RATIO IN SIZE BETWEEN

Your Antenna and Your Coil

The Fourth of a Series of Articles Written for POPULAR RADIO

"I propose here to interpolate, among calculated and practical considerations, a little theoretical point of some interest. For radio fans and amateurs surely like to think occasionally of the ether whose properties they are utilizing."—AUTHOR

By SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

IN electromagnetic waves the electric energy and the magnetic energy are equal. Or in more general terms, in every wave or system of waves, the kinetic and the potential energies are equal. This is obvious, because the energy alternates from one form to the other. At one instant it is static; at the next it is kinetic. Hence the two energies must be equal.

So it is also with the discharge of a Leyden jar, or any other capacity area. At one instant it is charged electrically, and at the next (that is, after a quarter swing) it is momentarily discharged, and all the energy is con-

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tained in the rushing current. Then once more the energy piles itself up statically in the opposite direction, and then swings back again. So it is, even in a swinging pendulum: the potential energy at the end of the swing is equal to the kinetic energy in the middle. So it is, also, in a vibrating spring.

Consider, then, a spring with a load on it, which you can set vibrating. At the extremity of the swing the energy can be called "elastic energy," or the energy of recoil. It is static. It depends on the elasticity of the spring: it does not depend on the inertia of the load. It does not depend on inertia at all; it would be the same if the spring was bent an equal amount and not loaded.

But now let the spring go, and consider what happens as the load is rushing past the middle position. The whole energy is now the energy of movement. It depends wholly on inertia, that is, on the massiveness of the load: it does not depend on the elasticity of the spring at all. It would be just the same for the same moving load if the spring were instantaneously abolished.

This energy may be called "inertia energy," or the energy of current or movement.

The elastic and the inertia energies must be equal. The spring adapts itself to them. Its rate of vibration is thereby determined. If it is a very stiff spring with a small load it will vibrate with extreme rapidity. It must—in order that the motion energy can equal the elastic energy. If, on the other hand, it is a weak spring heavily loaded, it will vibrate very slowly; because, since the energy is small, the motion of a massive body must be slow.

All this is elementary and simple mechanics. But now apply it to the electrical analogue. Are we to regard a Hertz vibrator, or a radio transmitting station, as represented by a stiff spring and a light load, or a feeble spring and a heavy load?

Or again, should we not rather try to arrange it so that the spring is moderately stiff and the load moderately massive, the one being adapted to the requirements of the other, and neither being over-balanced by the other?

Now in the electrical case, the oscillating thing is a group of electrons. They are very highly charged, but they are certainly not massive. They possess a kind of inertia due to the magnetic field which surrounds them when they are in motion. But the magnetic field due to a moving charge is but feeble, unless the charge is great and the motion exceedingly fast.

Now the electrons, though not massive, are highly charged, and they are presumably moving very quickly. Hence their current or magnetic energy is by no means negligible. But to bring it up to the required amount we must magnify it by coiling up the path of the electrons into a close spiral, so that all the magnetic fields reinforce each other, and give a large combined result. In that way, by the use of a sufficient coil, we may make the inertia what we please, and obtain the required amount of kinetic energy.

Now what about the static energy?

Here we must regard the ether as strained. And the ether's rigidity is excessively high. We know that; because of the rate at which light travels. Its elasticity compared with its density is accurately determined as equal to the square of the velocity of light; that is to say the ratio of the two is excessively great. A very small amount of distortion will account for a great amount of energy. But, to make room for all the electrons which are to take part in the discharge, an extensive area is required. If we use only a small area, we can hardly get any charge in it. It is like trying to bend a very stiff spring.

A tuning fork, for instance, can be

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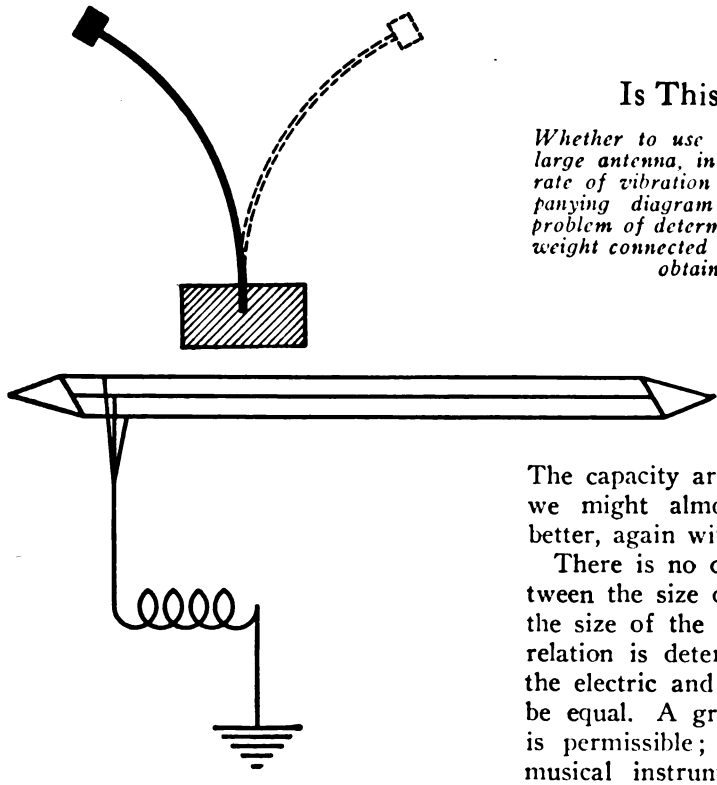

A

Is This Ratio Better—

Whether to use a small coil connected to a large antenna, in order to obtain a specified rate of vibration (as is shown in the accompanying diagram A), is analogous to the problem of determining whether to use a small weight connected to a large spring in order to obtain a similar result.

excited by a blow, or by a succession of timed impulses in synchronism with its natural period—which is practically what a violin bow does. Such a bow grips and releases a string or a spring in a synchronous and therefore effective manner. But a tuning fork hardly yields to a steady pull. The amount a small force can thus bend the prong of a stiff fork is insignificant. To be able to bend it sufficiently the spring must be long. And the greater the rigidity of the material the longer it must be. That means that in order to get an effective capacity area, it must be of large extent. It must be the most visible and conspicuous item in a radio station. On the other hand, the coil responsible for the magnetic energy may be quite small—we might even say the smaller the better, within certain limits. The capacity area should be quite big—we might almost say the bigger the better, again within certain limits.

There is no doubt a best relation between the size of the capacity area and the size of the inductance coil, and this relation is determined by the fact that the electric and magnetic energies must be equal. A great margin of variation is permissible; just as is the case in musical instruments, which may vary from the stiffness of a tuning fork to the laxness of the column of air in a flute, with all manner of strings and reeds as intermediaries.

So it is with a radio station. One may be working with a small capacity and a large inductance, while another one may be working with a great capacity and a small inductance; and yet both may have the same period of vibration; and will have, if the product of capacity and inductance is the same for both.

But there is sure to be a best relation between the two things; which, however overridden in practice, it may be instructive to consider.

And it is specially instructive to realize that the great size of the antenna, as compared with the small size of the coil which is in circuit with it, is an immediate consequence of the relation which exists between the two properties of the ether—its elasticity and its density. One is incomparably bigger

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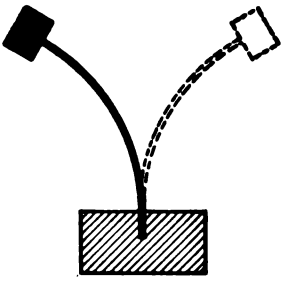
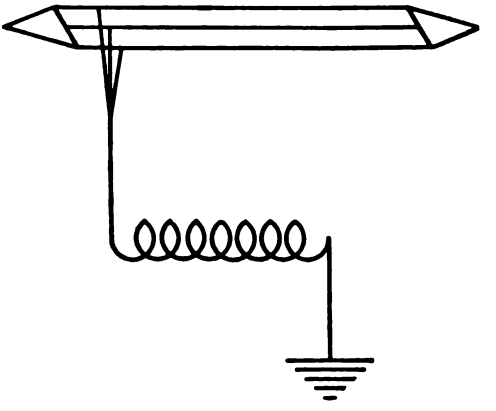
—Than This Ratio?

Or should the experimenter use a large coil connected to a small antenna, as shown at B, in order to obtain the same results as in diagram A? The problem is comparable to that of determining whether to use a large weight on a small spring to attain the same rate of vibration as a small weight on a large spring.





B

than the other. The ratio, in c.g.s. measure, is 10^{21}. Hence, we may say that the ratio between the size of an antenna—which depends on the ether's elasticity—and the size of the little coil—which depends on the ether's density—should also be of something like the order 10^{21}.

No, it can hardly be as big as that, even with the best possible arrangement. But it is legitimate to regard that as a sort of ideal, and to emphasize the importance of a big, as well as of a high, antenna, and of a small compact coil.

The size of the antenna has to be fixed by practical and often financial considerations. The size of the coil is at our disposal, and must be determined by the rapidity of vibration —that is, the wavelength that we want. And it must be adjusted so as to give this wavelength when worked in combination with the given antenna.

That, then, is the problem before us. Given an antenna of definite capacity, and required a certain wavelength, whether for receiving or for transmitting—but especially we will consider receiving—what sized coil shall we use, and what wire shall we wind it with?

Formulas that Help You Design Your Coils

THE *next article from the pen of Sir Oliver Lodge will deal with the theoretical considerations that are involved in coil design. The article will contain formulas for size, inductance and shape for coils for various wavelength bands. It deals with the subject from an entirely new viewpoint—and does it by means of a linear method of calculation of inductance and capacity. It will be an important addition to these articles of practical helpfulness to the amateur which have been contributed to* POPULAR RADIO *by this distinguished scientist.*

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From a photograph made for POPULAR RADIO

A SIMPLE TEST OF YOUR RECEIVERS

An improvised battery for testing the phones may be made in a few seconds. Merely place a penny and a nickel side by side on a piece of blotting paper and pour a little vinegar in between them. Then touch one phone terminal to the penny and scrape the other terminal on the nickel. A scratching sound will be heard in the phones if they are sensitive and in good working order.

USEFUL FACTS AND FOOLISH FALLACIES ABOUT

Your Earphones

Poor headsets offset the values of the best receiving apparatus. This article tells how to select good ones—and how to keep them in good condition.

By RAYMOND FRANCIS YATES

THIS article has really been prepared in a fit of rage. It happened this way. The writer was browsing around in a radio shop one day and happened to overhear a conversation between a salesman and an affable old gentleman who was being initiated into the mysteries of the art. He had purchased everything that was necessary for the construction of his first set with the exception of the headphones, and he appeared to be dimly conscious that this was about the most important part of his shopping. The clerk was one of those young wiseacres of the cake-eating, bun-dusting variety. He had a ready answer for any question and spoke with the authority of a Marconi. The old gentleman was just technically innocent enough to be gullible and he absorbed everything the young wizard told him as gospel truth.

"Yes, this is a good phone," our friend assured him. "It ought to be sensitive, it has a resistance of 3,500 ohms. . . . Yes, this other phone is better looking, but it is only wound to 2,000 ohms. You see, a 2,000 ohm phone cannot pass as much current as the 3,500 ohm phone and—"

The result of that conversation is this

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article. The writer does not wish to take the position of an austere technician, but he does wish to point out some facts about phones that are not generally known.

The headset is not only a little understood, but a much abused instrument. Yet how important the headset is! Without the headset we could hear nothing.

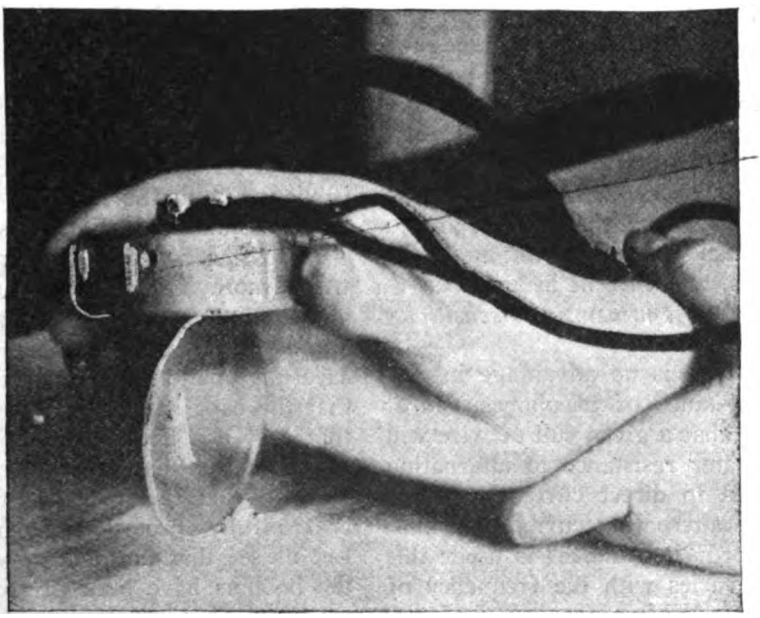
"Use a loudspeaker," you say.

But a loudspeaker is nothing but a telephone. It is the headset that converts the weak electrical impulses that surge through our radio receivers into audible sounds. Within them a mysterious transformation takes place. We have weak electrical currents. Presto! We have sounds. It is evident that we could not hear without headsets, and if we were to reduce a radio set to its very simplest elements we would have nothing but the detector and the headset. This should certainly impress us with the importance of this device.

In radio we deal with very weak currents. So weak, indeed, that if we interpose any great obstacle in their path they fade away into nothing, joining that vast store of wasted energy which lies safely beyond the reach of man. We take these weak struggling currents and convert the highest possible percentage of their energy into sound. When they enter the telephone receivers they enter for better or for worse. If the receivers are not correctly designed and carefully manufactured, part of the current will be irretrievably lost. Whether we shall or not hear DX (long distance) stuff does not depend altogether upon how sharply our circuits may be tuned or how perfectly our various other instruments are made. A long-distance signal may be detected only to be lost in the headset.

The radio telephone receiver is one of the most sensitive indicating instruments known to science, and it should be manufactured in a way that befits its high scientific station. We gain some idea of its sensitivity when we learn that a good headset will give an audible indication if a current that is only .00000000016 ampere passes through it.

What an infinitesimal amount of



From a photograph made for POPULAR RADIO

HOW TO TEST THE MAGNETS OF YOUR EARPHONES

If the magnets are in good condition, they are capable of lifting up the diaphragm.

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energy! Yet the telephone must have a certain degree of ruggedness even though it is called upon to detect currents that would make many sensitive electrical indicating instruments turn green with envy.

In the telephone we have two coils of very small wire wound about a steel core. Clamped tightly above these soft iron cores there is a diaphragm. The permanent magnets within the receiver case are in the proper magnetic relationship to the soft iron cores to allow the cores normally to exert a magnetic pull on the diaphragm. When a variable current passes through the coils or bobbins the magnetic pull of the diaphragm varies, and the diaphragm vibrates in sympathy with the current fluctuation. Since the diaphragm is in contact with the air it causes an atmospheric disturbance and sets up the sound waves which we hear.

So much for the theory of the telephone.

Now let us go into the matter of resistance, inasmuch as this was the point which goaded the writer into preparing this manuscript.

First and foremost, let us never be hoodwinked into purchasing a pair of phones because they have a high resistance. If there ever was a radio dumbbell it is the chap who believes that the sensitivity of phones is measured in ohms. We measure light in candlepower; heat in British Thermal Units; energy in foot-pounds, and current in amperes.

But, *we do not measure the sensitivity of phones in ohms.*

In fact there is no advantage in giving the resistance of telephones. Most of us know that a given coil of wire will offer a greater resistance to alternating current than to direct current. In the parlance of alternating current phenomena, the word "impedance" is used; this impedance varies with the frequency of the current. With a frequency of 400 cycles, a certain receiver may have an impedance of 3,000 ohms, and this may jump up to 5,000 ohms at 1,000 cycles.

Of course, the direct current resistance would be much lower than either one of these figures. If resistance were the only thing that counted, how simple a matter it would be to wind the bobbins of a telephone with some high resistance wire like German silver. In fact, there is a case on record where one manufacturer, either through ignorance or a deliberate attempt to defraud, wound his bobbins with German silver wire. They showed a beautiful resistance, but what they did to weak radio currents was a shame to say. It was a case of cold-blooded murder for everything but the heaviest currents.

Let us pass on, then, firm in our conviction that the resistance has little to do with the sensitivity of a headset.

Among other important items, the sensitivity of a headset depends upon the number of ampere-turns in a given space that the bobbins contain. It is the object of the conscientious headset manufacturer to crowd or concentrate as many turns of wire as possible into a minimum space. Some headsets have as many as 10,000 turns of No. 40 wire, and all this is crowded into a space that amounts to a fraction of a cubic inch. The phone manufacturer who knows his business does not wind his receivers merely to obtain a certain resistance. Each bobbin is wound with the number of turns of wire essential to get the best results.

Hereafter, when we buy receivers let us be more careful about their appearance and their reputation than their resistance. Let us see that the cases are carefully made with machined threads, that the caps have soft velvety surfaces that will not abrade the skin. Let us see that the diaphragms are perfectly flat and that the inside of the receiver is carefully protected from moisture. Let us see that the delicate windings of the bobbins have been protected with a covering. Let us also see that the pole faces have been carefully ground so that the receiver cap fits tightly. Then, if

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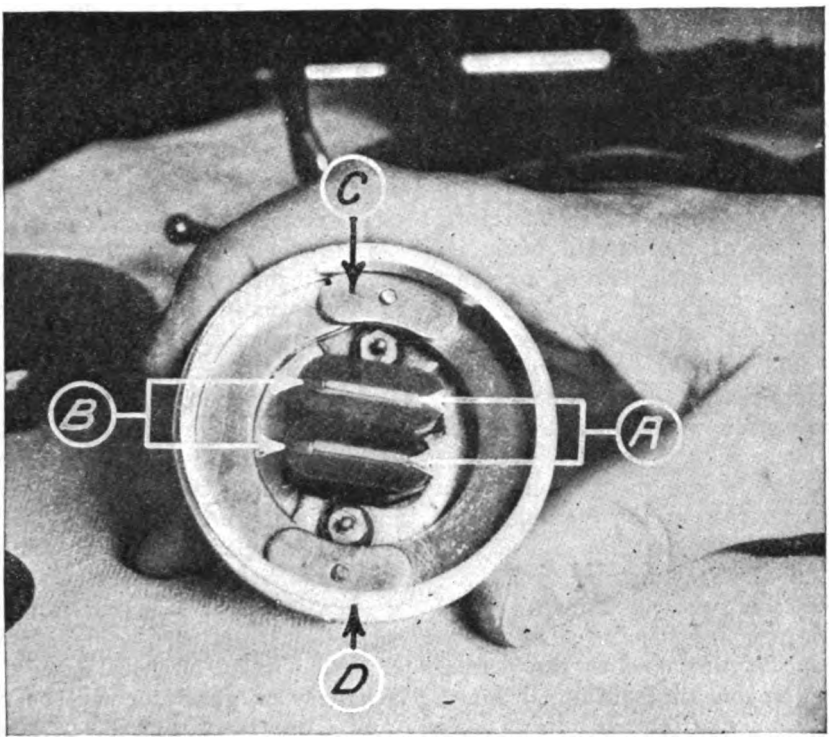

From a photograph made for POPULAR RADIO

THE INSIDE OF YOUR EARPHONES

The permanent magnets C, are fastened snugly inside the metallic case D, and have attached to their poles two pole pieces A, upon which are wound the bobbin coils B. It is the electric current flowing through the bobbin coils which causes the magnetic variations in the pole pieces that moves the diaphragm and produces sound waves.

we wish to test them on the spot, there is a way of doing that; it is indeed a poor phone that will not give an audible sound with the following little experiment. If we moisten a piece of paper on our tongues and place it between a penny and a nickel, a click will be heard in the phones when we bring the tips in contact with the coins. The two coins form the terminals of a miniature battery. If no sound is heard the phones are practically useless for radio and should not be purchased.

The ideal phone is the phone that will give maximum sensitivity and clear reproduction over a wide band of audio frequencies. The frequency of the sounds that reach us on the wings of radio are multitudinous. In the orchestra we have the high pitched violins, the low pitched trombone and other instruments representing a wide scale of vibration. The tiny diaphragm of our receivers is expected to be sensitive to all of these sounds; quite a job indeed. Every metal mass such as the diaphragm of a receiver has a natural period of vibration of its own; this means that it is particularly sensitive to a certain definite frequency. Of course, it will respond to other frequencies, but not so well. A good headset then is one that will give maximum sensitivity and clarity of tone over a wide band of frequencies. A certain type of receiver may have an exceptionally high sensitivity over a very narrow band of frequencies. This type of headset would not be suitable for radio, though many such headsets are on the market. The headset that brings maximum results produces a comparatively flat curve when it is subjected to these tests.

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Good receivers must also be matched in tone—each receiver must be the sound mate of the other. Even though two receivers have identically the same physical appearance as far as the eye can see, they do not always have the same acoustic properties, and therefore do not always emit the same tone. Therefore, it is the duty of the careful manufacturer to see that each pair of receivers that he places in a headset are matched. This assures us of faultless reception, which would not be possible with two receivers emitting different tones.

And now a few words about the proper care of phones.

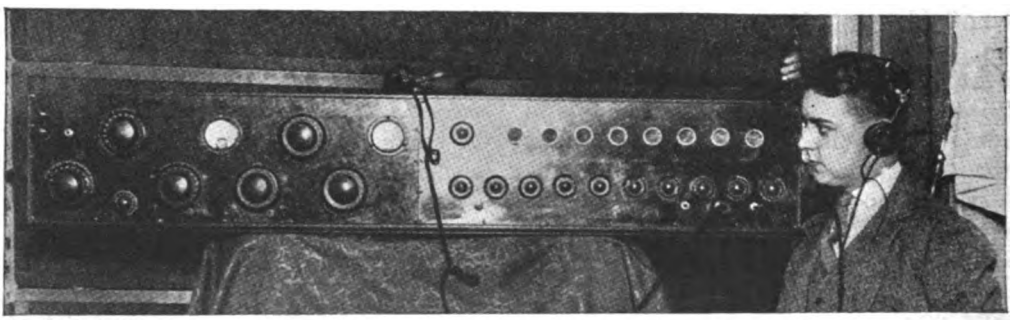
Some fans handle their phones with absolutely no respect for their delicacy. They quite forget that the abuse they heap upon them will sooner or later affect their sensitivity. Phones should not be dropped or handled roughly, as sudden shocks demagnetize the permanent magnets and they are apt to knock the receivers out of the adjustment made at the factory. The pole faces of a receiver should be able to hold the diaphragm on edge. If they cannot do this they should be sent back to the factory and remagnetized.

Care should also be taken in removing the caps of a receiver, and this should be done only when absolutely necessary. The diaphragm should be handled with the greatest care, and it should be slid off the case and not picked up with the fingernails. This is sure to bend it—and a bent diaphragm means an inefficient receiver.

Care should also be taken not to bend or twist the cord too much since this will eventually cause it to break. If we do happen to remove the receiver cap and diaphragm, we must take care to see that no particles of dust are allowed to remain in the case.

Alert headset manufacturers have recognized the necessity of building into their phones an impedance that would match the impedance of the vacuum tubes and amplifying transformers that are used with them. There is an old electrical law that tells us that maximum efficiency in an electrical circuit fed by a battery or generator will be obtained only when the external resistance (the resistance outside of the generator or battery) is the same as the internal resistance of the battery or generator.

So it is with telephones, transformers and tubes; their impedance should be matched.



Kadel & Herbert

A SET THAT PICKS UP EUROPE EVERY NIGHT

With ten tubes used in the famous Armstrong super-heterodyne circuit (which has been called the most sensitive circuit yet developed) R. R. Mayo of New York finds that there is not much "DX" that he cannot get. Using an outdoor antenna, he picks up the European stations not only under favorable conditions but almost every night. Detailed instructions for building a super-heterodyne set will soon be published in POPULAR RADIO.

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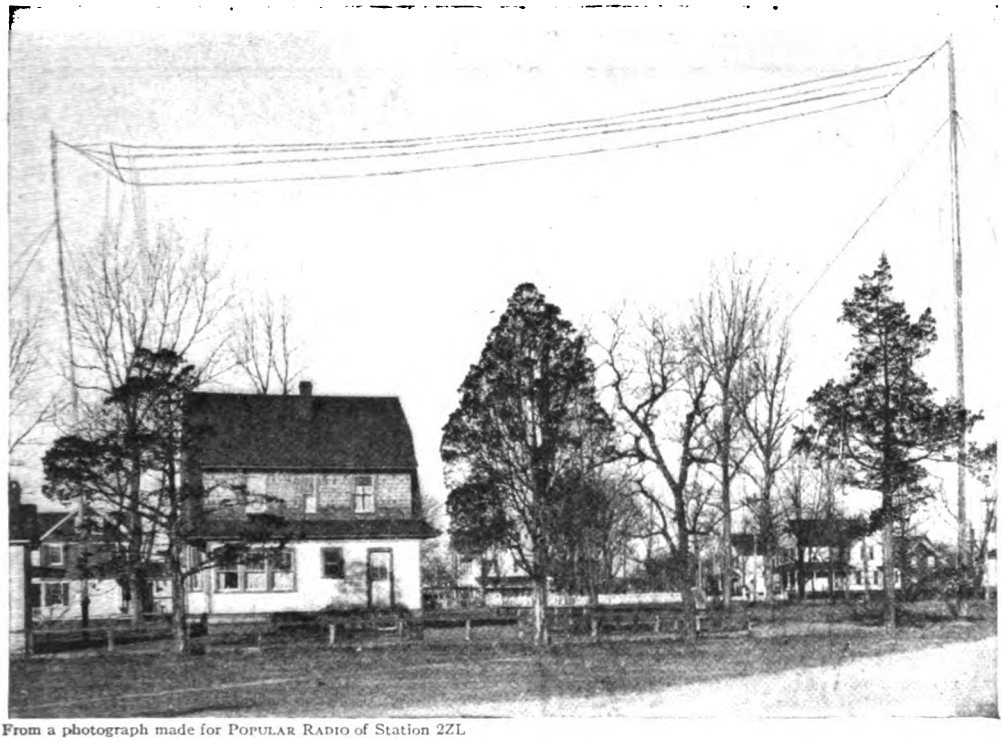

From a photograph made for POPULAR RADIO of Station 2ZL

KNOW THE CAPACITY OF YOUR AERIAL!

Everyone who uses either a receiving or transmitting set employs an antenna of some kind, and the value of his set is largely dependent upon the efficiency of it.

A MEASUREMENT CHART

FOR DETERMINING THE CAPACITY OF YOUR ANTENNA

ARTICLE No. 4

POPULAR RADIO has already published charts for calculating the correct inductance for coils in a radio set, and charts for calculating the dimensions for these coils. In using these charts it is imperative that the capacity of the antenna, with which the coils are used, be known. This chart enables you to calculate the capacity of your antenna so that you may use the preceding charts more readily.

By RAOUL J. HOFFMAN, A. M. E.

ONE of the most important, but extremely uncertain, of calculations in radio engineering and design is the determination of the constants of the antenna system.

Under the term "antenna system" we understand the total construction outside of the set, connected to it in order to transmit to or receive signals or from a distant radio station. These include the antenna proper, grounds, fire-escapes, bedsprings, or any other aerial system used to radiate or collect energy.

In the first article of this series* we showed that for a certain wavelength we require a certain amount of capacity and a certain amount of inductance. To use the charts in the first article, however, we were required to know the amount of

*Published in the February, 1923, issue.

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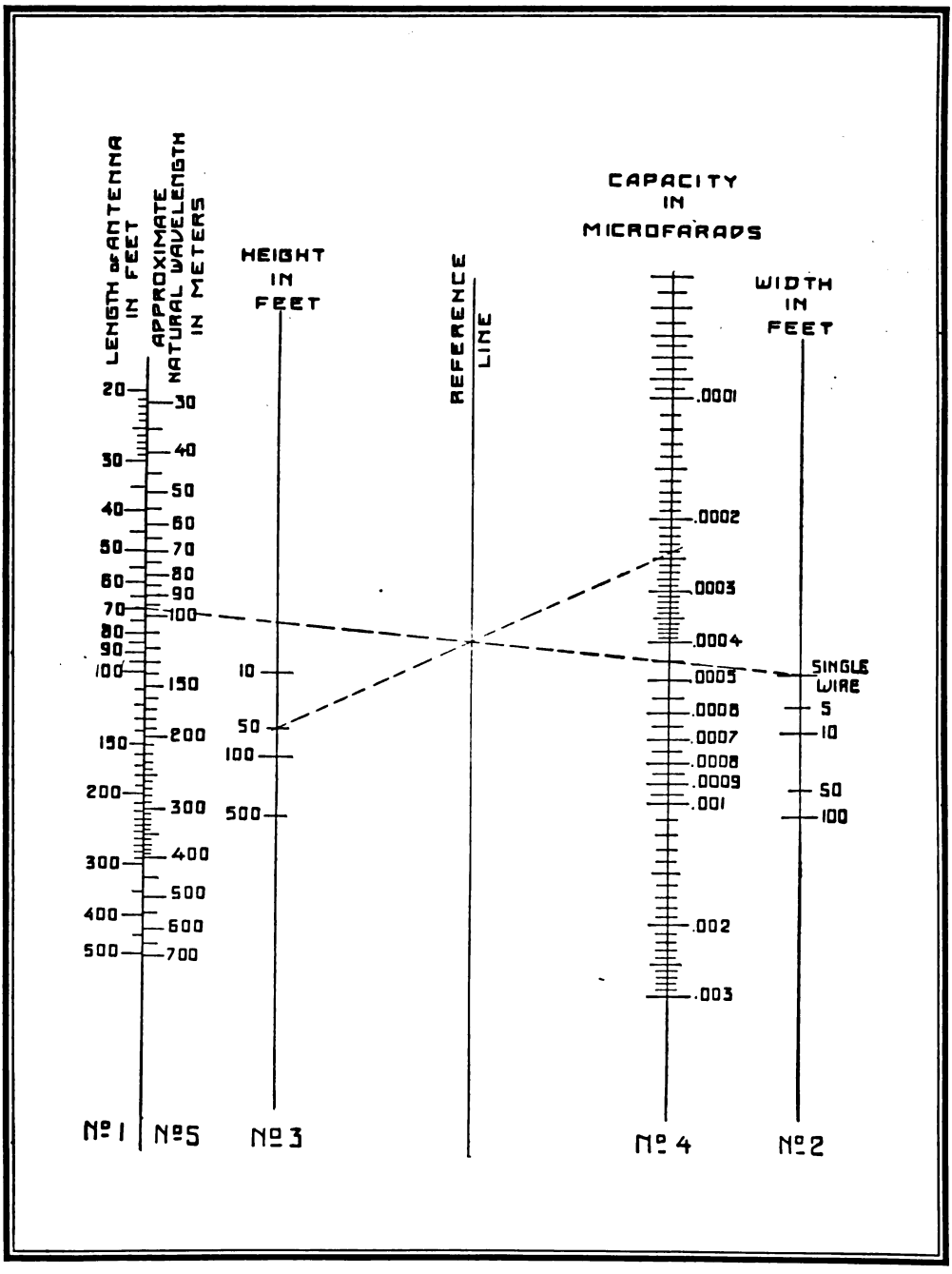

How to Use the Chart for Determining the Capacity of Your Antenna

With a ruler, connect the effective length of your antenna (scale No. 1) with the width of the antenna (scale No. 2). Then connect the effective height of the antenna (scale No. 3) with the intersection of the first line and the reference line. Carry the line out over scale No. 4—which will indicate the capacity of the antenna.

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capacity incorporated in the design of our antenna, in order to calculate the correct coil to use with our antenna for a given wavelength.

In this article, then, we are introducing a chart that gives us the capacity of our antenna, with the requisite amount of accuracy to calculate the proper inductance for the coil to use with it.

To take advantage of simplicity, without deviating from accuracy—and the practical radio engineer always welcomes simplicity—we will neglect the inductance of the antenna, as it is small in comparison with the inductance of the coil to be used with it. This will not materially affect our calculations.

The chart (shown with this article) for calculating the capacity and fundamental wavelength of our antenna system is derived from data obtained from many experimental tests and laboratory experiments on vertical and horizontal antennas.

We will readily see by trying a few calculations on imaginary antennas (with the aid of the chart) that the longer and wider (or the more wires used) our antenna is constructed, the more capacity it will have, and the higher up it is suspended the less capacity it will have.

The chart has five scales.

Scale No. 1 indicates the effective length of the antenna (figuring the full length of the horizontal part and half the length of the vertical part.)

Scale No. 2 contains the width of the antenna; (it also indicates the imaginary width to use for the single wire antenna). When more than one wire is used, the width will be the distance between the outer wires. The wires should be spaced not closer than two feet and not farther apart than four feet in order to be effective.

Scale No. 3 indicates the value of the effective height from the ground.

Scale No. 4 gives the resultant capacity in microfarads.

Scale No. 5 gives the approximate natural fundamental wavelength of the antenna, which corresponds to the values on the Scale No. 1, and in accordance with the standard formula:

$$\lambda = 1.38\, l$$

wherein λ = the natural wavelength of the antenna in meters,
and l = the length of the antenna in feet.

Let us work out the following example in order to understand clearly how to use the chart:

We have an antenna with a 45-foot horizontal, single-wire stretch, a 40-foot vertical lead-in, and a 10-foot ground connection.

Taking the full amount for the horizontal wire (45 feet) and half the amount for the vertical part

$$\frac{(40 + 10)}{2} = 25 \text{ ft.}$$

We will have an effective length of $(45 + 25) = 70$ feet.

Connecting 70 on scale No. 1 with the mark "single wire" on Scale No. 2, and then connecting the point of intersection (of this line we have drawn with the reference line) with the effective height of the antenna $(40 + 10) = 50$ feet, on Scale No. 3, we may read the resulting capacity of the antenna on Scale No. 4.

The approximate natural wavelength of this antenna would be about 97 meters.

Save These Hoffman Charts!

By means of the "radio slide rule" originated by the author of the above article radio amateurs everywhere have been able to save a vast amount of time and at the same time insure accuracy in their calculations in the design of radio apparatus. The ingenious charts reproduced in this series constitute an equally valuable contribution to the science of radio. The previous articles contain charts for *Determining the Constants of Radio Circuits and Calculating Capacities of Condensers in Series,* in February, 1923; *For Determining the Dimensions of Your Coil* in March, 1923 and *For Determining the Capacity of a Condenser* in May, 1923.

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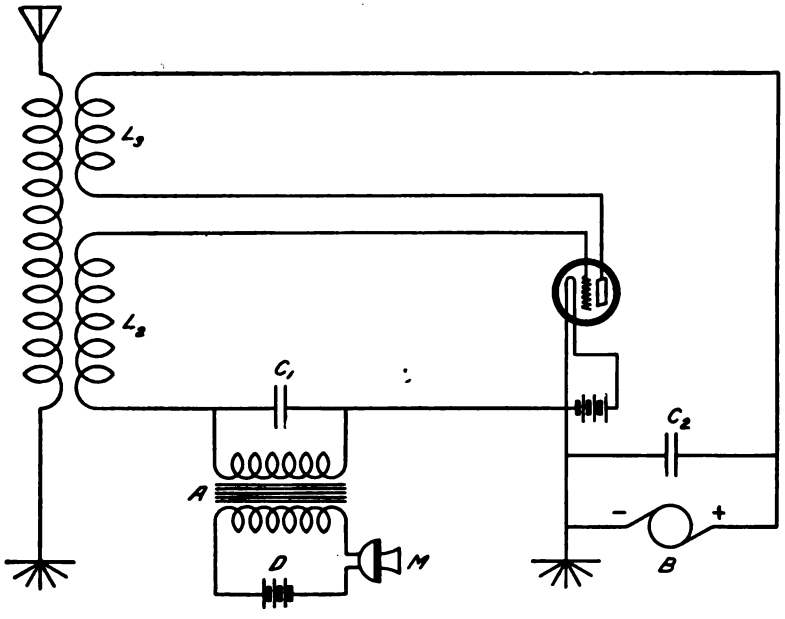

FIGURE 1

The circuit diagram for a low power single-tube telephone transmitter that employs the grid method of modulation.

FOUR WAYS TO GET GOOD MODULATION

PART II

The four standard methods may be listed as (1), the use of the microphone in the antenna circuit for low-power transmission; (2), the use of a magnetic transformer*; (3), grid modulation and (4), Heising modulation. The latter two of these methods are here described by one of the foremost authorities in this field—*

PROF. J. H. MORECROFT

WHEN a vacuum tube is used to generate the high-frequency power sent off from the antenna by a radio telephone transmitter, the very rigid control which the grid potential exerts over the plate current offers a ready means for modulating the plate current—and the plate current controls the amount of power which the tube supplies to the antenna.

An arrangement suitable for a small transmitter that uses one tube is shown in Figure 1. When proper coupling is used between coils L_1, L_2, and L_3 the tube will oscillate and supply alternating current to the antenna, the frequency of which is approximately that fixed by the inductance and capacity of the antenna circuit.

The amount of plate current which the D. C. generator B, supplies to the tube is determined by the potential of the grid of the tube, and this potential is controlled in turn by the voice currents set up by microphone M, acting on the grid

*See POPULAR RADIO for May, 1923

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through transformer A. The condenser C_1, is advisable as it facilitates the oscillation of the tube; it must not be more than about .001 microfarad, however, otherwise distortion of the speech will result.

In some sets there is also connected across the secondary of transformer A, (called the "modulation transformer") a resistance of about one megohm; it is supposed to improve the quality of the speech. The condenser C_2, is advisable, not only to facilitate the setting up of oscillations but also to protect the insulation of the armature of machine B, which is subjected to high-frequency dielectric losses if not shunted by this condenser.

The modulation transformer A, must be especially designed for the microphone and tube with which it is to be used. It generally has a fairly high transformation ratio, sometimes as much as twenty-five to one.

The primary coil, in series with the microphone, must be of low resistance, as low as that of the microphone itself or lower; if not, the variation in microphone resistance, brought about by the voice waves, will not materially affect the current from battery D, and if this current does not fluctuate there will be no voltage induced in the secondary coil and so the tube output will not be controlled.

It might seem advisable to wind the transformer with an extremely high ratio (say five hundred to one), so that even with but little fluctuation in the primary current sufficient voltage will be induced in the secondary to properly modulate the antenna output. Such a high ratio would require a great many turns of fine wire in the secondary, however; this would be sure to bring about speech distortion as the consonants, the high-frequency waves of the voice, would not be repeated through the transformer.

The voltage transformation ratio of a transformer is not the same for all frequencies; if the secondary has a great many turns this ratio decreases very rapidly for the higher voice frequencies.

This effect is suggested in Figure 2 which gives the ratio of transformation for such a transformer; for the high voice frequencies the ratio is much less than for the lower ones, so that the high-frequency consonants would not come through the transformer with their proper relative magnitude and the voltage affecting the grid potential would be deficient in consonant sounds. The power radiated from the antenna would

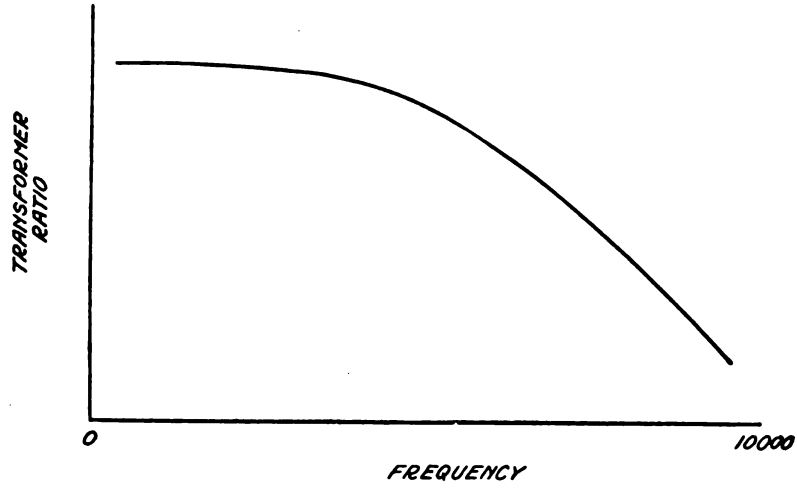

FIGURE 2

Curve showing how the voltage transformation ratio, for a modulation transformer which has a great many secondary turns, decreases with an increase of frequency.

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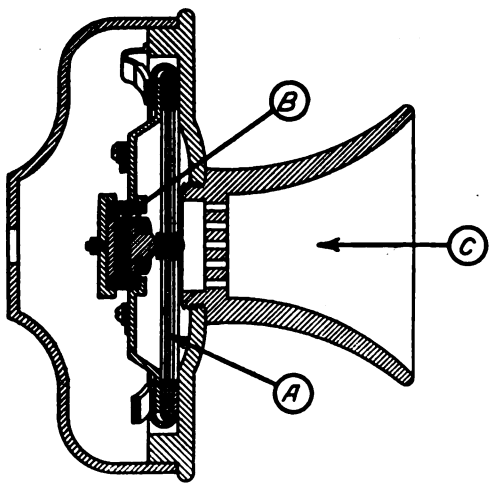
thus be deficient in the high-frequency sounds of the voice and the speech received by the listener would be drummy and indistinct, no matter how good the receiving set might be.

It is to be pointed out however, that even if the quality of the speech sent out by the broadcast station is excellent, an improper adjustment of a regenerative receiving set will always make it seem poor. A transmitting station is frequently blamed for poor speech quality when actually the quality is spoiled right in the receiving set itself; we shall analyze this point later.

The scheme given in Figure 1, which we have just examined, called *grid modulation,* is not all that might be desired because even with the best adjustment it is impossible to obtain a high percentage of modulation (which causes wide variations in the antenna current) without getting poor quality.

As long as we are content to change the amplitude of the antenna current by perhaps 25 percent (or in other words get 25 percent modulation) the quality of received speech is fair, but when it is pointed out that in radio telephone transmission *it is the change in amplitude of the antenna current brought about by the voice and not the actual antenna current,* which determines how far the signal will carry, it is evident that some scheme that will permit greater modulation is to be desired.



HOW SOUND WAVES ACT ON THE CARBON GRAIN MICROPHONE

The sound waves enter the mouthpiece C, and vibrate the diaphragm A, which causes the carbon grains B, to be compressed and released, thus varying the current that flows through the microphone.

Such a one is indicated in Figure 3; in Europe it is called *plate modulation* or *choke-coil modulation,* but in the United States it is styled the Heising scheme of modulation, because Heising was responsible for its development in this country.

This Heising method of modulating the antenna current is almost universally used in the better class broadcasting stations of today; although it is expensive to install and maintain compared to the other schemes, the quality of speech obtained when it is properly adjusted makes it far superior to any other method so far devised.

Many radio enthusiasts seem to object strenuously to this scheme because they have to "waste" half their tubes; only half of them are oscillating to produce antenna power and their antenna current is much less than when they connect all their tubes in parallel to act as oscillators to supply power to the antenna, and modulate by the grid method.

With all the tubes acting as oscillators the antenna current is about 50 percent greater than when connected for the Heising modulation scheme; hence it seems as though the Heising scheme must be inferior to the other. But we have to again emphasize the fact that such a judgment is based on a misconception as to what radio telephony really is; as stated before the reading of the antenna ammeter is no criterion at all regarding the usefulness of a set to transmit telephone signals—it is the *variation of antenna current* produced by the voice that measures the station's efficiency and *not the antenna current itself.*

One transmitting station that has two amperes of current in the antenna as read

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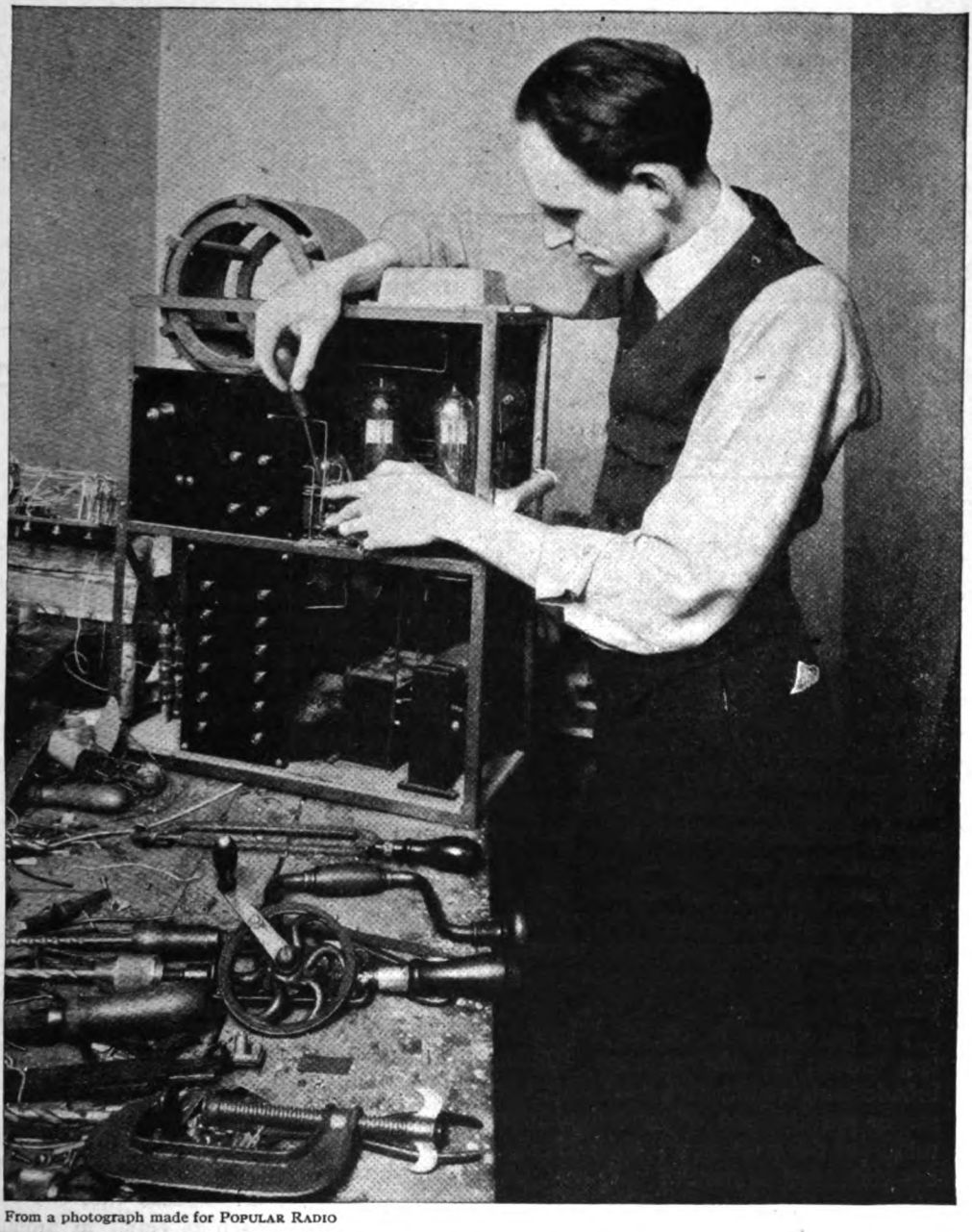

From a photograph made for POPULAR RADIO

BUILDING A SET THAT EMPLOYS THE HEISING SCHEME OF MODULATION

In this type of set one tube is used as an oscillator and another tube (of the same power) is used as a modulator. The circuit diagram for this set is shown in Figure 3, which indicates how to connect the two tubes in the correct way.

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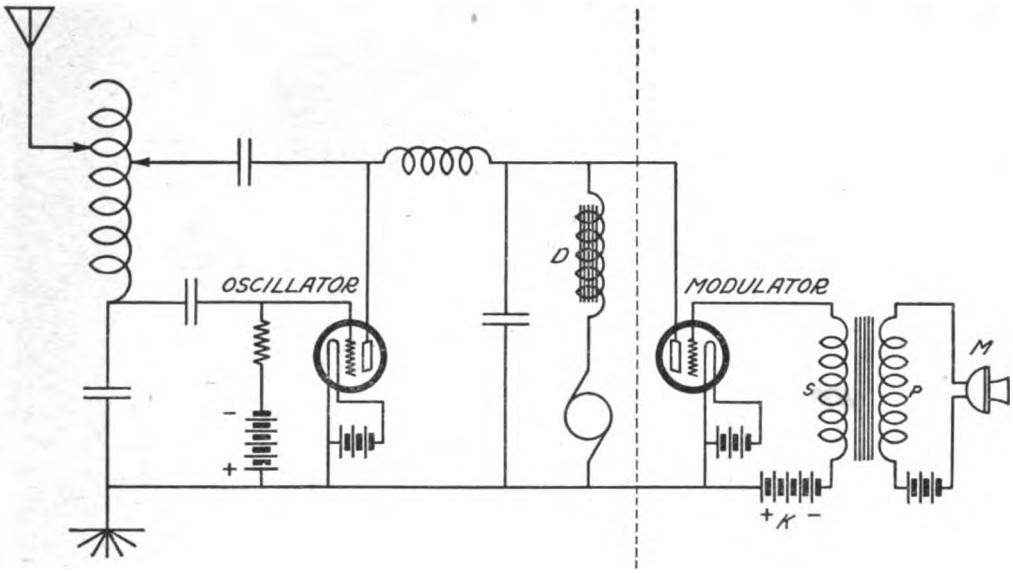

FIGURE 3

This diagram shows how to wire up a set employing Heising modulation. All the apparatus shown at the left of the dotted line is in the oscillator circuit and the apparatus at the right of this line is connected in the modulation circuit. This is the scheme of modulation used at all the larger broadcasting stations.

on the hot wire ammeter, using the Heising modulation scheme, should be able to telephone twice as far as is possible for another station that has a much greater antenna current with a less perfect system of modulation.

In some of the large stations used for broadcasting it has sometimes seemed advisable actually to use more tubes for modulators than were used for oscillators.

The set shown in Figure 3 has only two tubes; in the average 500-watt broadcasting station two oscillators operate in parallel and either two or three tubes (of the same size as the oscillators) are connected in parallel with each other to act as modulators. The connection scheme shown in Figure 3 was used extensively during the war for Signal Corps sets and for the sets used on naval vessels. The circuit is divided by the dash line to indicate the two parts; all the apparatus to the left is used to make the oscillator function to furnish the high-frequency power to the antenna while that to the right is the required addition to the circuit to speech-modulate the antenna power.

The two tubes, oscillator and modulator, both draw their plate current through the iron-core choke coil D; for the ordinary five-watt tubes this coil should have an inductance of about two henries. The grid biasing batteries and filament current of both tubes are so adjusted that the plate current of each is equal and equal to about half the total possible plate current, fixed by the amount of electron emission from the filaments.

In Figure 4 is shown the static characteristics of the two tubes (supposedly the same for each); the grid of each tube is so adjusted in potential that the current taken by each is equal in amount to AC of Figure 4, this equality of currents to be obtained when the oscillator tube is oscillating and no speech is acting on the microphone of the modulator. This means that the grid battery K of the modulator must have the voltage OB and that the grid battery voltage of the oscillator, plus whatever resistance

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drop there is in the grid leak due to the grid current taken by the oscillator, is also equal to OB.

As the amount of grid current flowing in the oscillator tube depends upon the adjustments of inductance, coupling, etc., the proper amount of grid battery for the oscillator cannot be obtained when the oscillator is not operating; an ammeter should be put in the plate circuits after the set starts to oscillate and the amount of grid battery adjusted to give equality of plate currents (the currents in the two plate circuits will not then be equal when the set ceases to oscillate). The amount of plate current in the oscillator, AC, corresponds to a certain definite amount of power in the antenna.

If the grid of the modulator tube is now made to go up and down in potential, about the point B of Figure 4, the plate current of this tube must go correspondingly up and down. As both tubes get their plate currents through coil D, however, and as this has sufficient choking action (the technician says it has sufficient *reactance*) to maintain the current through itself essentially constant, the plate current of the oscillator must go down and up by the same amount that the modulator current goes up and down. The sum of the two currents must continually be equal to twice the current AC.

This means that if the modulator current decreases to the value AE, (Figure 4,) the oscillator plate current must rise to AG so that AE plus AG is equal to twice AC. As stated before, the power in the antenna depends directly upon the amount of plate current supplied to the oscillator tube so that it is evident that the microphone M, controlling, through the modulation transformer S-P, the grid potential of the modulator tube, actually controls the amount of alternating current in the antenna. Moreover the control exercised by this connection scheme is such that the fluctuation in amplitude of the antenna current represents the voice waves actuating the microphone M, more faithfully than is the case for any other modulation scheme so far tried.

In the large broadcasting stations the microphone does not directly control the potential of the modulator tube grids, so it is necessary to use some intermediate

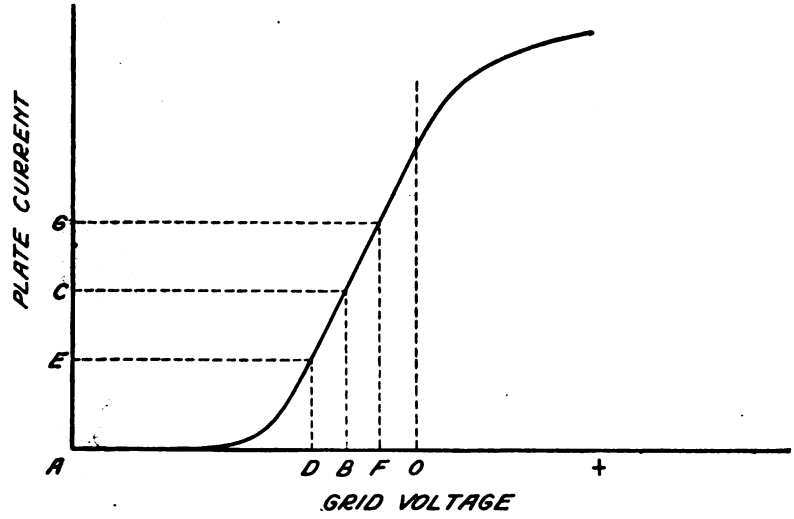

FIGURE 4

The characteristic curve for the tube. This chart is shown in order to make clear the action of the modulator and oscillator tubes as explained by the author in the text. The curve actually shows the increase of plate current caused by an increase of voltage applied to the grid circuit.

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tubes for amplifying. Thus the microphone into which the broadcaster talks works into an ordinary resistance-coupled, two- or three-tube speech-amplifier which controls the grid potential of a five-watt tube; this tube controls the grid potential of a fifty-watt tube, which, in turn, acts directly on the grids of the modulator.

In this manner have the skilled researchers in this branch of radio communication developed that wonderful system of control by which the micro-watts, sent out by the voice, control, accurately and instantaneously, the kilowatts of power necessary for communicating the hundreds and thousands of miles which are now easily covered by all of the best radio telephone stations.

How Uncle Sam Is Helping the Farmer by Radio

No better demonstration of the practical usefulness of radio can be offered than the remarkable service which the Department of Agriculture is rendering, directly and indirectly to the farmers, through the newly created Radio Market News Service. Just what this service is and how it operates will be told by Harry A. Mount in a near issue of POPULAR RADIO.

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THE AUTHOR SHOWS THE SIMPLICITY OF TUNING

An unusual feature of this home-made set is the fact that it requires only one dry-cell for its operation.

HOW TO MAKE A DRY-CELL TUBE

REGENERATIVE SET

At a Cost of Less Than $16.00

This is a peculiarly suitable receiver for the novice to begin with—particularly the beginner who wants to make every part of the set himself and thus learn from actual experience how a receiver works and how to work it.

BY SPENCER W. BOYD

THE writer recently made a vacuum tube set, with tube and batteries, *that cost under $16.00.* The set works splendidly. Located in Atlanta, it has received clearly, even through heavy summer static, stations at Pittsburg, Detroit, Chicago and Shreveport, La.

The set is operated in connection with a single-wire antenna 100 feet long and 20 feet high, and no amplification is used. A regenerative circuit is employed with two home-made variometers for tuning. A saving in cost is made by using a WD-11 tube, which requires only one dry-cell for the filament instead of a storage battery.

The Parts that are Needed

A list of materials needed to construct this set is here given:

1 vacuum tube, type WD-11	$6.50
1 rheostat	1.00
1 dry-cell "A" battery	.35
1 22½-volt "B" battery	1.75
2 knobs and dials 3 inches in diameter with ⅛-inch bushing	1.50
7 binding posts	.70
1 .001 mfd. phone condenser	.35
1 grid leak and condenser	.35
150 feet No. 26 S.C.C. wire	.50
6 collars and set-screws for ⅛-inch rod	.30
1 ⅛-inch rod, 8 inches long	.10

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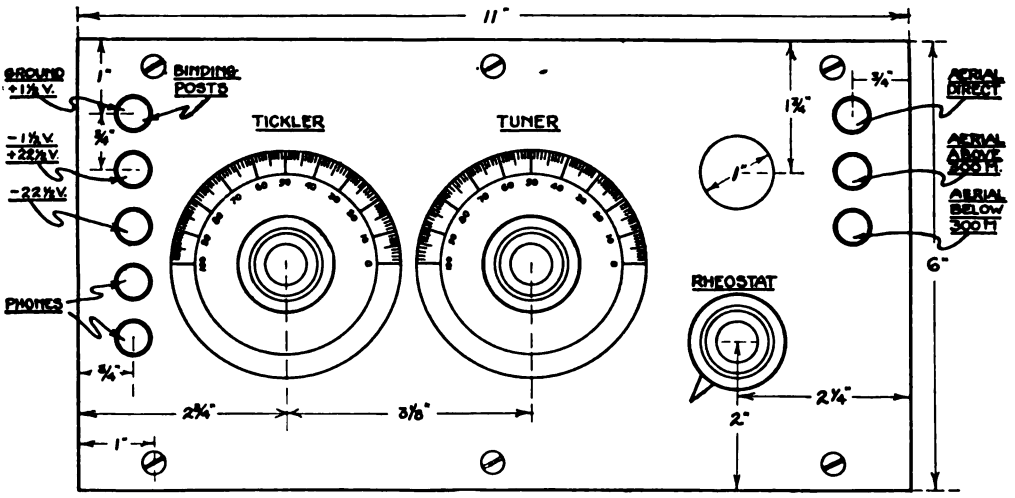
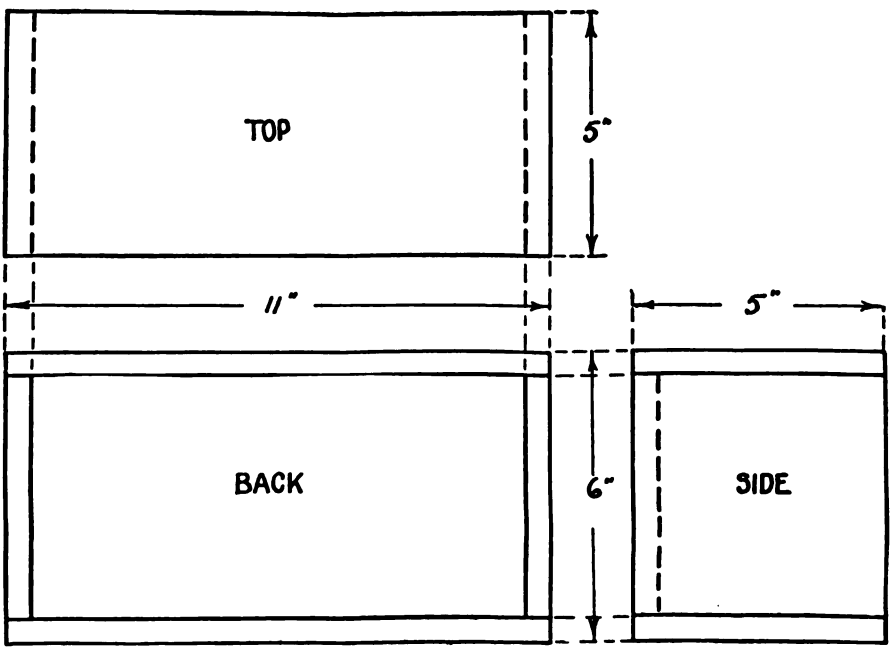


THE PANEL LAYOUT OF THE SET

FIGURE 1: *This diagram shows arrangement of the dials, knobs and the binding posts for the connections to the antenna, ground, batteries and to the telephones.*



THE DIMENSIONS OF THE CABINET

FIGURE 2: *This may be made at home from a plank of hardwood—or the diagram may be sent to a carpenter who can build it to order.*

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1 piece ½-inch oak, 5 inches by 4 feet	
1 piece ¼-inch 3-ply wood, 6 inches by 11 inches	
1 smaller piece	
Nuts, bolts and screws	
1 cardboard tube 3¼ inches in diameter and 6 inches long	
2 cardboard tubes 2¾ inches in diameter and 1¼ inches long	
1 cardboard tube 1⅞ inches in diameter and 2 inches long	
Tinfoil, sheet copper, angle brackets, paraffin, stain and shellac, totalling.	2.00
Total.....	$15.80

The phones and the material for an antenna are not mentioned in the above list; almost everyone who is likely to build this set will already have them. Good phones cost about $8.00, and the required antenna equipment should not cost over $1.50.

All of the listed materials are easily obtainable—except perhaps the copper sheeting, of which a piece about 6 inches by 12 inches is required. But this may be taken from a worn-out copper tank, such as all plumbing shops have. The copper should be extremely thin, so that it may be cut easily with small scissors.

The wood can be purchased at a furniture factory or lumber yard. The oak should be cut the required width and thickness; the expense is small and a great deal of trouble is saved.

How to Build the Set

The cabinet is made from the oak and measures (outside dimensions) 11 inches long by 6 inches high by 5 inches deep. Details are shown in Figure 2. The front is left open and the panel, when it is attached, is screwed flat to it. When the cabinet is finished, give it a light coat of stain and then one of shellac.

If you wish to spend more time you can easily make a more elaborate cabinet, but this one is satisfactory.

The panel (Figure 1) is made from the larger piece of 3-ply wood. Bore all the holes and then give it several coats of dark stain. When this has dried, wax the cabinet with floor wax and polish it well.

The tuning element consists of two variometers, the stators of which are both wound on the same tube so that they are inductively coupled.

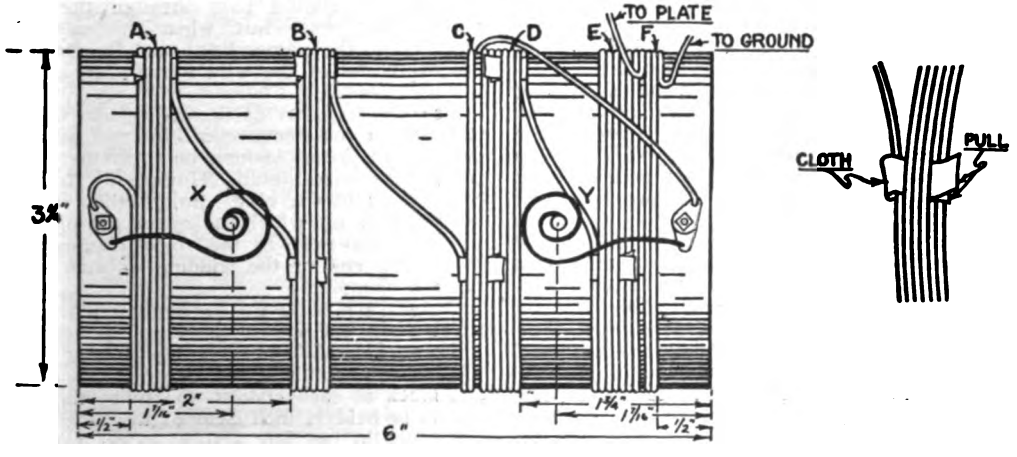
Three tubes should be obtained, one 6 inches long and 3¼ inches in diameter and two 1¼ inches long and 2¾ inches in diameter. If tubes the right size cannot be obtained you can make them either by cutting down larger ones or by using thin cardboard rolled several times about a form. In any case give them two coats of shellac and shrink them in a hot oven.

The stator tube with six groups of windings, lettered A, B, C, D, E and F, all of which are wound with No. 26 S.C.C. wire, is shown in Figure 3.

Wind D and E with one wire to form the stator of the right hand variometer. D and E should be wound first; begin at the left and wind to the right in the direction indicated. D consists of seventeen turns and begins 2⅛ inches from the right end of the tube. E also consists of seventeen turns and begins 1⅛ inches from the right end.

Now put on A, B, C and F.

A and B each consist of seventeen turns; they start ½ inch and 2 inches respectively



HOW TO MAKE THE TUNER

FIGURE 3: *This drawing shows how to space the stator windings on the tube and how to fasten the ends of the windings with a small bit of cloth.*

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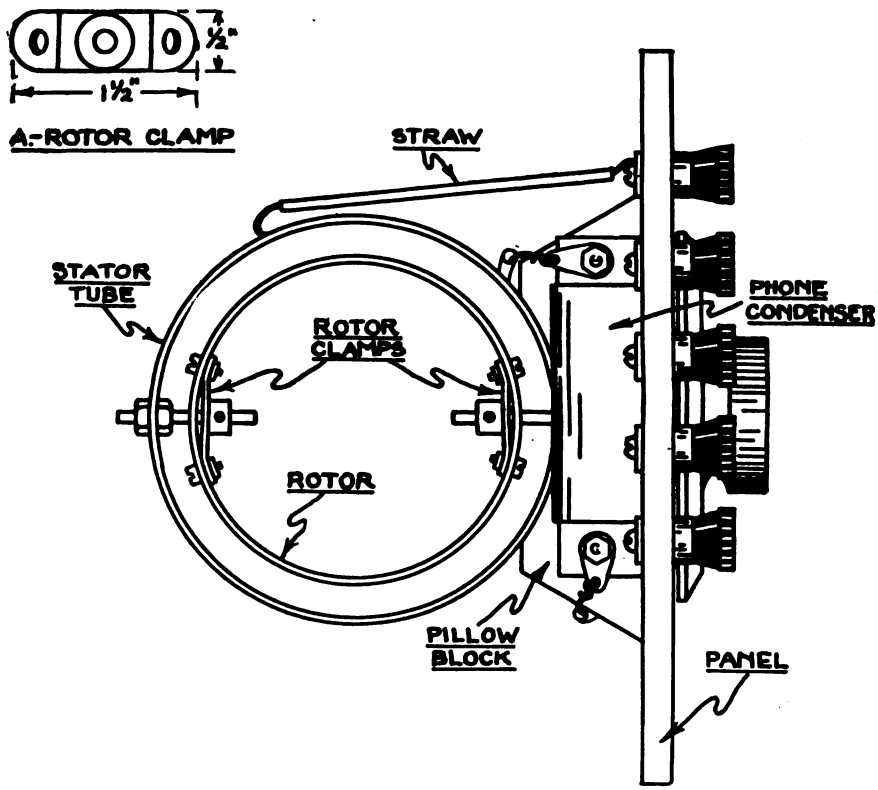

HOW TO MOUNT THE COILS AND THE CONDENSER AND THE BINDING POSTS

FIGURE 4: *The rotors of the variometers are fastened to the shafts by means of two ingenious rotor clamps which are tightened on the shaft by set-screws.*

from the left end of the tube. C and F each consist of six turns and are wound as close as possible to D and E. When the wire is led from one coil to another it is held in place by a loop of cloth as shown in Figure 3, except the wire from C to F which is led through holes in the tube and under D and E.

Now punch the holes in the tube as shown. X and Y are ⅛-inch holes and form the rear bearings for the rotor pivots. Holes in the panel form the front bearings. Cut two ½-inch holes in the front of the tube directly opposite X and Y. Shellac the tube lightly to hold the wire in place.

The two rotors are exactly alike, each being composed of thirty-eight turns of wire on one of the 1¼-inch by 2¾-inch tubes. When you wind the rotors leave a ⅛-inch space clear of wire in the middle of the tubes for the rods to pass through. Wind the wire in the same direction as you did on the larger tube. Run the ends of the wire through holes in the tubes to fasten them, and shellac the wire to hold it in place.

The four rotor clamps are each made from a collar with a set-screw and a ½-inch by 1½-inch piece of thin sheet metal. Bore three holes in each piece of metal as shown in Figure 4 and solder the collars directly above the middle ones. Bolt the clamps inside the rotors (Figure 4).

The bolts should pass through the open spaces that were left when the coil was wound, and the clamps lined up. Be sure that the insulation of the wire is not damaged by the bolt heads.

Use 6-inch pieces of flexible insulated wire to make the rotor connections in front and run these through the ½-inch holes in the stator tube. Use wire pigtails (Figure 3) for the connections in the rear. Solder them to the ⅛-inch rods on which the rotors are pivoted. Clamp these rods in the rotor clamps, and solder one end of the winding of each rotor to each clamp.

Mount each rotor in the large tube on two short rods cut from the long ⅛-inch rod (Figure 4). Make two pillow blocks from ½-inch wood to hold the stator tube. Screw one block at each end of the tube; the tube should be held ½ inch clear of the panel.

If you do not buy a tube socket you can make it as follows:

Use a piece of ¼-inch 3-ply wood, 3 inches by 3½ inches, for the base of the socket (Figure 5). Cut out a space in front to make

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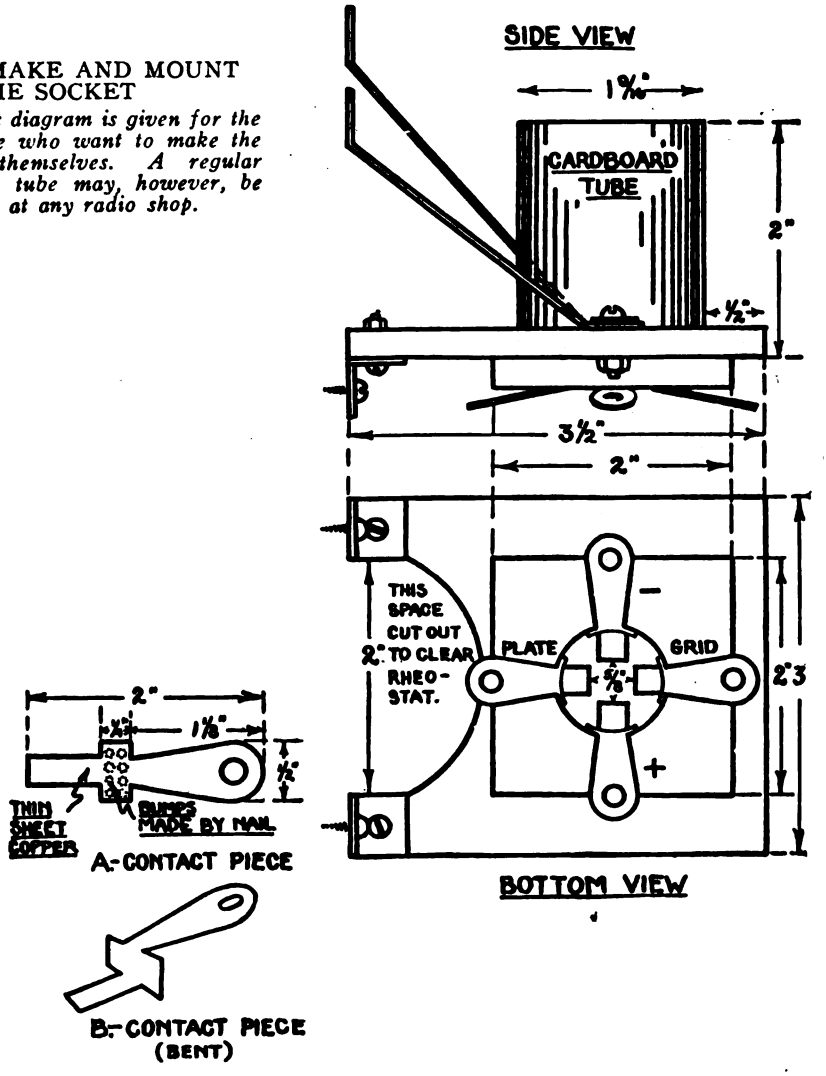
HOW TO MAKE AND MOUNT THE SOCKET

FIGURE 5: *This diagram is given for the benefit of those who want to make the whole outfit themselves. A regular socket for the tube may, however, be procured at any radio shop.*



room for the rheostat; cut a 1⅝-inch hole in it and mount a short cardboard cylinder for a tube guard. Fasten the frame to the panel by means of two angle brackets and two metal strips, one of which should be shorter than the other in order to clear the antenna binding posts.

Take a piece of 3-ply wood 2 inches square and bore holes in it to fit the prongs of the tubes. Now screw it under the cardboard tube. Make the holes a little larger than the prongs. Contact with the vacuum tube is made with the contact pieces; cut them from the copper and bend them as shown in Figure 5, and insert them in the holes. They should grip the prongs firmly when the tube is inserted. Bore holes in the ends of contact pieces so that the connecting wires may be bolted to them.

The antenna condenser (Figure 7) is made from three pieces of thin wrapping paper 1¼ inches by 2 inches, two pieces of tinfoil 1 inch by 2½ inches and one piece 1 inch by ½ inch. Solder a wire to one end of each piece of tinfoil. Lay the condenser out as shown, roll it up and dip it in melted paraffin and then press it under a weight.

Cut a piece of the sheet copper about 5¼ inches by 9 inches with a tab left on one corner, and tack it to the back of the panel. The tab should be fastened under the ground binding post, so that the copper will form a shield for the instruments. Cut that portion of the sheet which is around each hole in the panel so as to make it clear of all the binding posts, except the grounded one.

How to Assemble the Set

When these details are completed, the set may be assembled. The position of the instruments is shown in Figure 1.

Screw all the instruments to the back of the

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panel with wood screws, which should be sawed off flush so as not to break the outside finish of the panel. When mounting the instrument be sure that no metal part that is not supposed to be grounded touches the copper shield.

Mount the rheostat first; then screw on the pillow blocks and upon these screw the stator tube. Before fastening on the tube slip a collar with set screw over each of the ⅛-inch rods that project from the front of the tube. When the tube is mounted the rods should extend ½ inch through the panel.

Now screw the tube socket directly behind the rheostat. Fasten the antenna condenser a little above and to the left (figuring from the back) of the stator tube.

The phone condenser is supported by two angle brackets (Figure 4); fasten these under the two required binding posts. If a condenser is purchased that measures 2¼ inches between its terminals it will fit perfectly.

The hook-up for the set is shown in Figure 6.

Connect the small piece of tinfoil in the condenser with the low wavelength binding post, the middle piece with the set, and the other piece with the high wavelength binding post. In Figure 1 a third binding post is shown, but it is not necessary; it cuts out the condenser entirely and is for use only in connection with an exterior variable condenser. If you own a variable condenser of .001 mfd. capacity you can use it; in this case no other antenna condenser is necessary.

No. 26 wire may be used for connections, but heavier wire (about No. 18) is better. Cover the connecting wires with varnished-cambric tubing. If this cannot be procured paper straws, such as are furnished in soda fountains can be used.

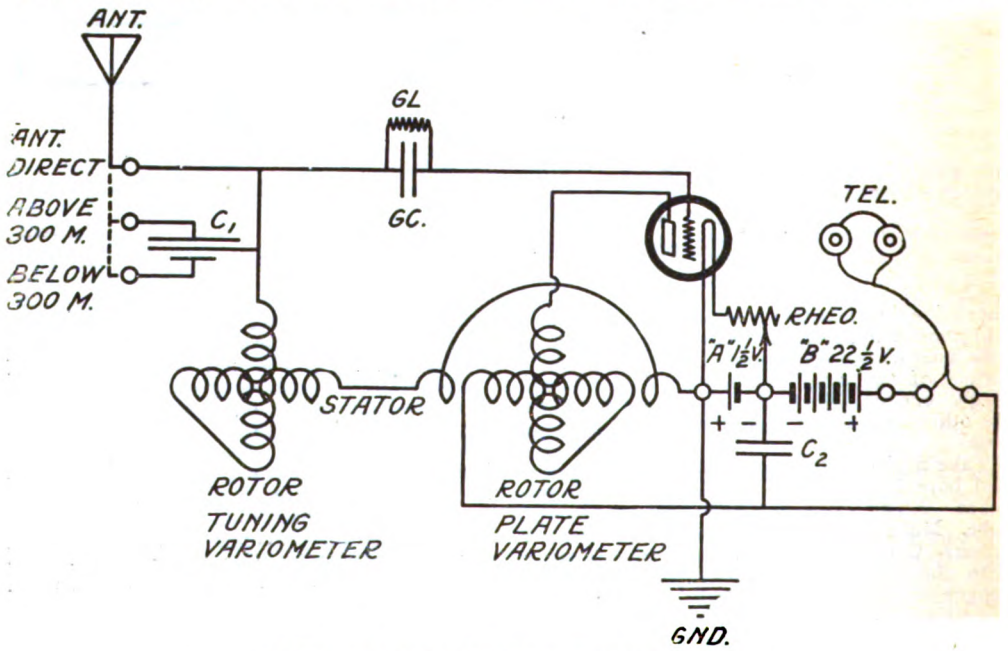
Do not solder any connections; soldered connections are not advisable in a home-made set, for if any part of the set ever needs to be changed or removed all the connections have to be melted. It is better to solder a copper tab to the end of every connection wire. These tabs offer a large surface for contact and are easily fastened under the binding posts and bolted to the terminals.

Cut two spring washers from thin metal, slip one over each of the ⅛-inch rods that project from the panel, and fasten the knobs and dials on top. The dials, together with the collars back of the panel, should be adjusted so that the rotors can turn freely in the stator tube. Fasten the dials at such a position on the rods so that when the scales are at 100 the rotor windings will be parallel with the stator windings; any current passing through the variometers will then traverse both windings in the same direction.

Fasten the panel on the cabinet with six ¾-inch round-head screws; the set is then complete with the exception of the connections of the batteries, phones, antenna and ground. These are shown in Figures 1 and 6.

How to Operate the Set

The tuning of a set cannot well be described in an article; skill in tuning can only be ac-



HOW THE SET SHOULD BE WIRED UP

FIGURE 6: *The instruments are here shown diagrammatically in their proper parts in the circuit. The wires connecting them together should be run from one instrument to the other in the shortest path without touching any other instrument.*

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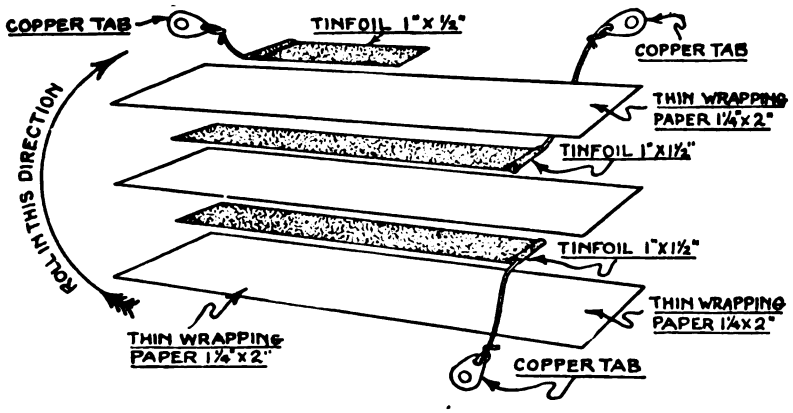


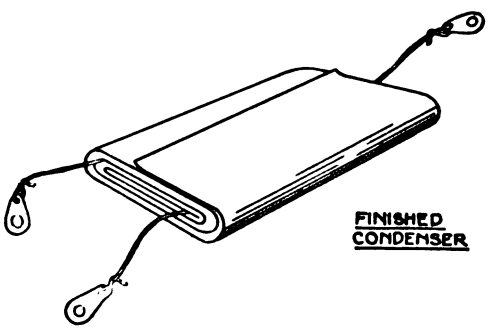
HOW TO PREPARE THE CONDENSER FOR ASSEMBLY

FIGURE 7: *The layers of tinfoil and paper should be cut to the sizes shown and placed one on top of the other.*

quired by practice. A good plan is to locate a friend who owns a set of his own and have him help you. Do not expect to be able to tune in at first any desired station immediately.

If you experience any trouble in making the tube oscillate when the antenna is connected to the high wavelength binding post, you will probably find that your antenna condenser is of too high capacity; you may have to experiment with it to suit your antenna. Adjust it so that a signal that is received on the low-wave binding post with the dials at 100 will be received with the same intensity on the high-wave post with the dials at about zero if the rheostat position has remained fixed.

The construction of the set here described will enable you to start in on long distance reception without great expense. Later on you may add audio frequency amplification; any type of audio frequency amplifier can be used with this set. It is a simple set for a beginner; yet in this way it can be converted easily into a set for the more advanced fan.



THE FINISHED CONDENSER

After the connecting tabs are fastened to the tinfoil plates the condenser should be rolled up and it will present an appearance as shown here.

How to Build and Operate the Five-tube Loop Antenna Set

IN *the next issue of* POPULAR RADIO—*August—will appear a full description of how to construct the newest Cockaday set—a five-tube inductively tuned receiver that consists of two stages of radio frequency amplification with compensating condensers, a vacuum tube detector, and two stages of audio frequency amplification. As it operates effectively on either a loop or a short indoor antenna, it reduces to a minimum the interference due to static, and is, therefore, an ideal set for use in summer.*

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From a photograph made for POPULAR RADIO

THE CIVILIAN RADIO EXPERT OF THE ARMY

Dr. Louis Cohen, the associate of Major General Squier of the Signal Corps, who advised with his chief in the development of the code that promises to speed up transmission between 200 and 300 percent.

The NEW SIGNAL CODE

The most radical change proposed since the Morse alphabet was devised 80 years ago; what it is and how it works

By LOUIS COHEN, Ph.D.

IN the art of electrical communication we are concerned with the production and transmission of signals and the character and combination of the signals for the interpretation of intelligence; therefore a comprehensive study of electrical communication must take account of these two aspects of the art which are so closely related and interdependent.

The methods and means which are employed for the production and transmission of signals should necessarily depend upon the character of the signals transmitted; a change in one will necessarily involve a change in the other. Any study looking toward the increase in efficiency of electrical communication must take into consideration these two aspects of the problem, and this, of course, is true, irrespective of the methods employed for the transmission of the signals, whether it is radio, line telegraphy or submarine

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telegraphy. In the different methods of signal transmission, different equipment and methods have to be employed, but in each case the development of any new methods and means for the production of signals will depend on the character of the signals, and any development, therefore, should logically proceed along these two lines simultaneously; a change in one may require a change in the other.

As a matter of fact, the efforts of engineers have been directed heretofore exclusively to the development and improvement of methods for the production of signals without any regard to a possible change in the character of the signals themselves. In all methods of communication, radio or line telegraphy, we are still using the Morse code, based on the combination of the dot and dash in exactly the same form as proposed by Morse some eighty years ago. It looks as if engineers have taken it for granted that no possible improvement on the Morse code could be made, and they therefore have not given the subject any attention whatsoever. It is remarkable, indeed, that so much engineering ingenuity should have been spent on improving, in the minutest detail, the methods of production of signals, and no consideration at all given to any possible change in the character of the signals themselves.

A new method of signaling has recently been described by Major General George O. Squier. In it the dot and dash signals of the Morse alphabet are differentiated by a difference in *intensity,* instead of a difference in *time-interval,* as is the practice now.

The difference in the two methods is of greatest importance in effecting economy in time of signaling. In the present practice, every dash signal occupies a time-interval three times that of a dot signal, and in the Squier method the dash signal does not require any more time than the dot signal. General Squier accomplishes this by the use of an alternating current in which each half cycle, or even multiple thereof, represents a dot or a dash, the two being distinguished by a difference in intensity. In the case of land lines or submarine telegraphy, an alternating current of the desired frequency is directly impressed on the line and the signaling accomplished by varying the intensities of the half cycles, or multiples thereof. For radio signaling the carrier high-frequency current is modulated by a low-frequency alternating current, and here again the modulating alternating current is varied in amplitude to produce the desired signals. It is clear that in the case of submarine telegraphy only low-frequencies can be transmitted, and therefore to obtain any speed at all in signaling it will be necessary to make every half cycle represent a signal, a dot or a dash. On the other hand, in line telegraphy, where higher frequencies may be employed, considerable speed in signaling may be obtained by using several half cycles for each signal; that is to say, we could use, say, a 60-cycle alternating current or even 100-cycle alternating current, if desired, and assign for each signal a certain number of half cycles, depending upon the speed of signaling desired. The advantage of using several half cycles for each signal is that greater accuracy is thereby insured, because even if during the time-interval of each signal anything should occur to disturb the character of the signal, there is the possibility that some of the half cycles would retain their character, and the signal could therefore still be interpreted.

The same reasoning applies also to radio signaling. Here again we can modulate the carrier high-frequency current by a low-frequency alternating current of any desired frequency and assign to each signal a certain number of half cycles, depending upon the modulating frequency employed and the speed of signaling desired.

It is believed that this method offers, among others, two great advantages:

First, an increase in speed of signaling; which means of course an increase in the efficiency of the system.

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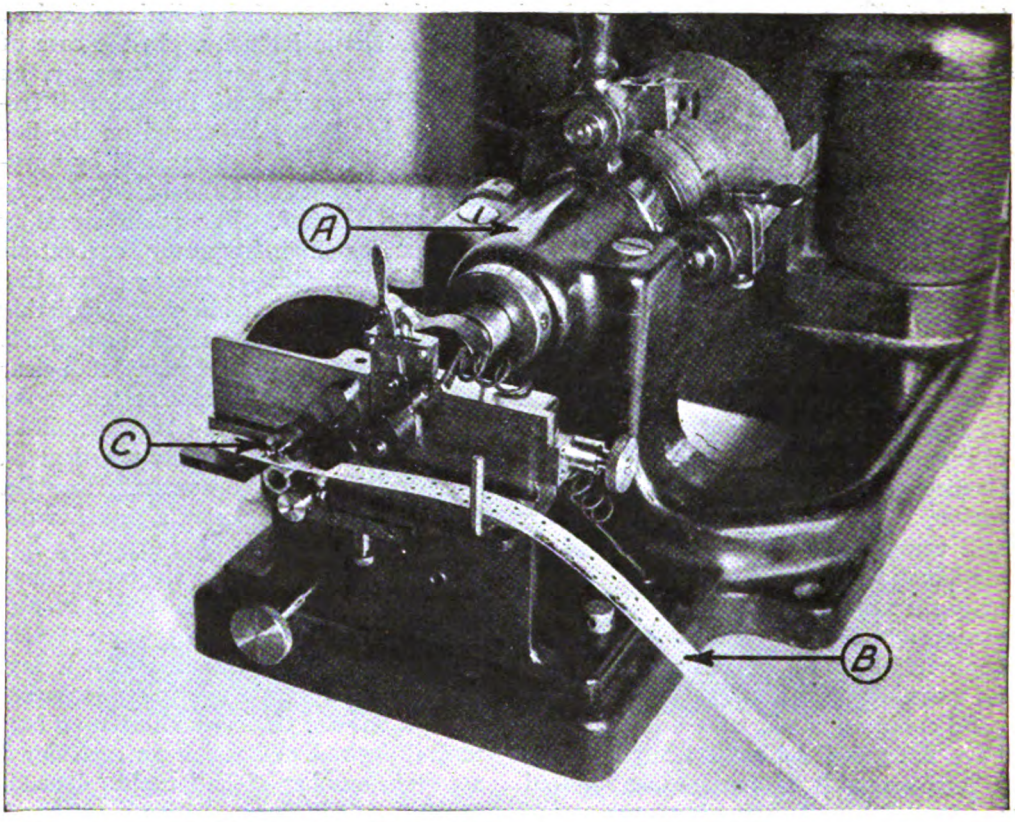

A MECHANICAL TRANSMITTER FOR THE NEW SQUIER CODE
A shows the driving motor; B shows the tape; C shows the roller. This apparatus may be used in connection with either radio, line telegraph or submarine cable.

Second, greater reliability and accuracy.

If we remember that by this method we can assign, say six or eight or even ten half cycles for each signal, the possibilities of errors in interpreting the signals are greatly reduced. Even in the case of static disturbances some of the half cycles of each signal may be affected in character, but there is still the possibility that some of the half cycles will retain their identity, thus enabling the operator to recognize the signals.

It is true, of course, that in varying the amplitude of each succeeding half cycle, or changing the amplitude of a group of oscillations, a transient effect is produced which must be carefully taken into consideration. This is a problem which can be investigated and is now being investigated, mathematically, and it is hoped the results will be available before long. But it must be remembered that the change in amplitude required in order to distinguish between a dot and a dash need not be large, a change of the order of magnitude of ten percent will probably be sufficient, and therefore the transient effect produced by this small change in amplitude will not be large. Hence it would appear that the general considerations of this method, as outlined by General Squier, will not be upset seriously by these transient effects accompanying the changes in amplitude in signaling.

Another advantage of this method is that a much higher degree of selectivity can be obtained. In the present method the variations produced by the dot and

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dash signaling are irregular in their character; the time-interval required for the dot and the dash are of the ratio of 3 to 1, and therefore no tuning to the signaling frequency is at all possible. But in the method proposed by General Squier, the signaling frequency is fixed, and the character of the signals is uniform, the variations following practically sine-wave form, and therefore it should be possible to tune both mechanically and electrically to the signaling frequency, which in the case of radio signaling would be the modulating frequency. We can by this method, in the case of radio signaling, effect a double tuning, first tuning by the usual means to the carrier frequency, and then again tuning mechanically and electrically to the low modulating frequency. It would seem that this method should offer possibilities of remarkably sharp selectivity, which is, of course, an advantage which can hardly be overestimated.

This method also offers a solution to the problem of multiplexing. There does not seem to be any reason why we could not, with advantage, modulate the carrier frequency by several different modulating frequencies and transmit several messages simultaneously on the same carrier frequency. At the receiving stations the messages could be easily separated by tuning to the modulating frequencies. This is a matter which is of pressing importance in radio signaling because of the limited number of wave channels available for transmission of intelligence. At the present time, when the demand for radio transmission is increasing from day to day, the problem of finding enough wave channels to satisfy all the demands is an urgent one.

Now it would seem that by changing the character of the alphabet, adopting the method proposed by General Squier, the speed of signaling would be increased and also the use of one carrier frequency for transmission of several messages would be made possible, and thus the number of wave channels available for handling the radio traffic of the world would be increased.

A question may be raised in regard to the methods for interpreting the signals at the receiving end. The present methods will not do, since the operator could not differentiate the small difference in intensity between the dot and dash by receiving the signals in the ordinary telephone. The difficulties, however, are not of any serious consequence. In the first place, it must be remembered that if any great speed in signaling is desired, mechanical sending and receiving must be resorted to, and this method lends itself readily for machine operation, the signals being transmitted by tape in the usual way and received at the other end either by recording the signals, or by having them operate a page printer. But even if, for some reason, it is desired to transmit the signals by hand and receive them by audition, this can be accomplished in various ways. One of the methods which has been suggested is to have the two signals of different intensities; that is, the dot and the dash operate local circuits in which audible notes of different character are continuously generated, and thus the operator will hear two notes of different character which he could learn quickly to interpret as the dot and the dash.

From an engineering standpoint, therefore, this new method of signaling does not offer any serious problems which could not be met by present day engineering practice; at the same time it offers the advantages of increased speed, higher efficiency, and greater selectivity.

HOW A RECEIVED MESSAGE APPEARS

By remembering that the long *impulses represent the dashes of the old code and that the* short *impulses represent the dots of the old code, any one who knows the Morse alphabet can decipher this phrase.*

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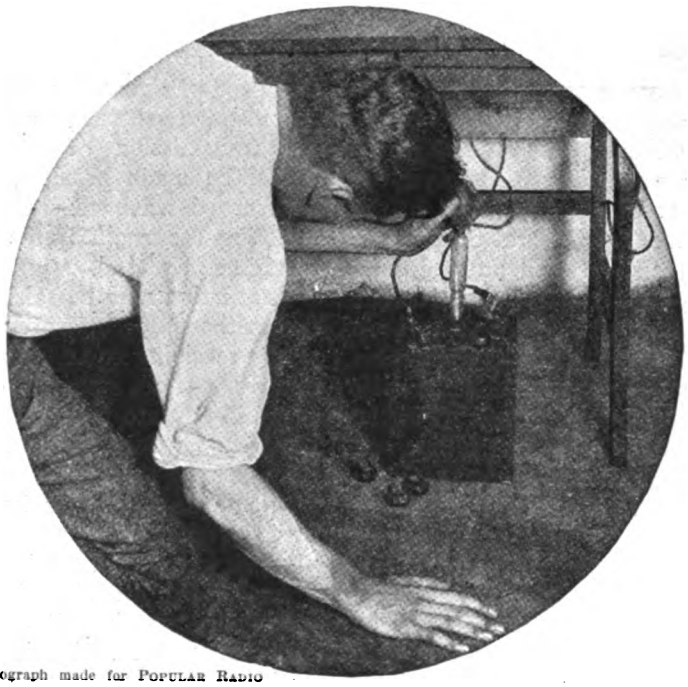

From a photograph made for POPULAR RADIO

TAKE YOUR HYDROMETER READING ONCE A WEEK

The full charge hydrometer reading of a lead acid cell should be between 1.250 *and* 1.300, *and the battery should never be discharged below a reading of* 1.18.

How *to* Keep Up Your STORAGE BATTERY

By HENRY STRAHLMAN

AMONG the questions that the radio amateur asks most frequently are: What is a storage battery? What is it used for? How does it store up electricity?

As the proper maintenance of the amateur's radio equipment is largely dependent upon an intelligent understanding of the workings of this important device, his questions may be answered simply as follows:

First: A storage battery is a device for storing energy at one time for use at another time. Energy is first put into it in the form of electricity and is delivered from it in the same form. The process of putting energy into a battery is termed "charging." When the battery is delivering energy, it is "discharging."

Second: A storage battery is used to light the filament of one or more vacuum tubes of a radio receiving set.

Third: A storage battery does not store up electricity; it stores up a chemical action which, when the battery is connected, generates electricity. A lead-acid battery consists of a number of cells; each cell has a number of positive and negative plates. Both plates have as their backbone a cast grid made of a stiff lead alloy. These grids act merely as supports for the active material in the plates. These plates differ only in the composition of the active material with which

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they are filled. The positive plates are filled with brown peroxide of lead and gray spongy lead in the negatives. There is also the electrolyte, which is the solution in the battery and which consists of a definite mixture of sulphuric acid and distilled or other "pure water." When the current is taken from a battery, a certain part of the solution combines with the plates, leaving the solution weaker.

For purposes of illustration, consider a six volt, sixty ampere hour battery of the lead acid type, which has been discharged and needs recharging.

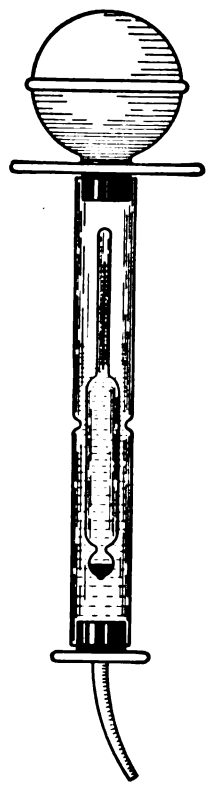
Such a battery may be recharged in several ways. If you have direct current, you may use a thirty-two candle power lamp, connected in multiple as shown in figure 1. If you have alternating current, a number of rectifiers that are on the market will serve the purpose, such as the Tungar bulb rectifier or the magnetic rectifiers. These rectify the alternating current and turn it into direct current, as all storage batteries must be charged with the direct current.

Before you put the battery on charge, make sure which is the positive and which is the negative terminal of the battery. The positive is marked "Pos." or + or is painted red; the negative is marked "Neg." or —, or is painted black. The polarity of the charging wires (if they are not marked), may be determined by placing them in a glass of water to which a teaspoonful of salt has been added; if you do this make sure that the wires are not too close together. Fine bubbles of colorless gas will collect on the negative wire under water.

The positive terminal of the battery must connect with the positive wire of the charging circuit and the negative terminal of the battery must connect with the negative wire of the charging circuit.

The battery is now on charge. The direct current flows through the plates and the solution, causing a chemical action which takes off that part of the solution that had combined with the material in the plates during the discharge and returns it to the solution again. Great care should be taken that the charging rate is not greater than the correct charging rate of the battery. (This is usually shown on the manufacturer's nameplate).

In other words, let us assume that the charging rate of the battery is five amperes, and the battery is a sixty ampere hour type. Therefore we will charge it for twelve hourse. For example: 5 amperes $\times$ 12 hours = 60 ampere hours. However, this should be determined by means of a hydrometer or hydrometer syringe. By inserting the end of the syringe in the filling holes of the battery



The battery solution is drawn up into the outer glass tube of the hydrometer syringe by means of the rubber bulb at the upper end. The narrow part of the floating indicator is graduated, much like a thermometer, to read in "specific gravity." The point where the surface of the liquid crosses the scale on the float gives the correct reading.

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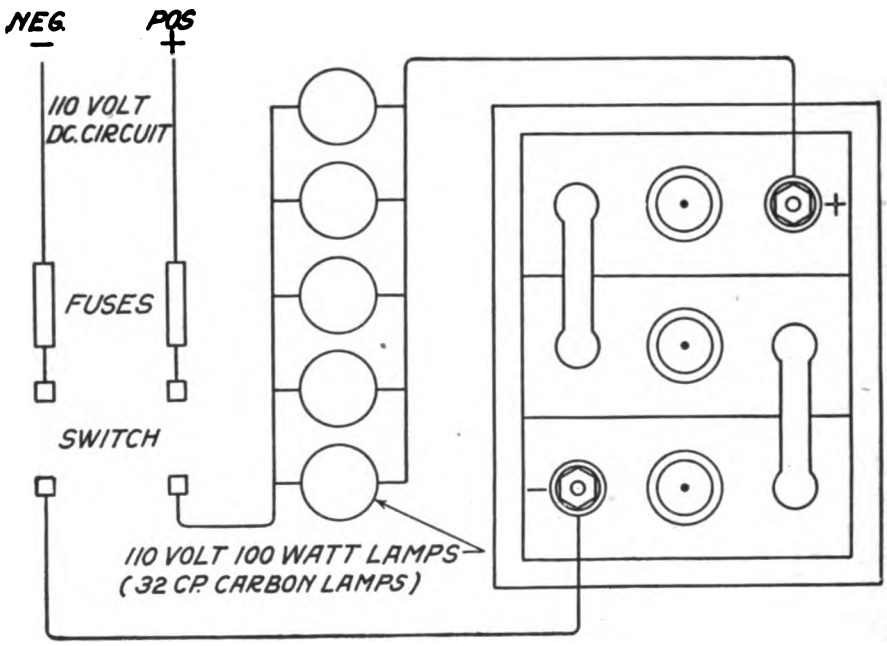

A CIRCUIT FOR CHARGING YOUR BATTERIES FROM THE D. C. LIGHTING MAINS

This diagram illustrates the connections that should be used with a 110-volt D. C. lighting circuit through a bank of lamps. Be sure that the positive terminal of the lighting main is connected to the positive terminal of your battery.

and by drawing up enough solution to float the glass bulb inside of the instrument, the reading of the scale at the surface of the liquid gives the strength of the solution, which must be between 1.250 and 1.300 when the battery is fully charged.

Another way of making sure that a battery is fully charged is to leave it on charge for two or three hours after each cell has started to gas or bubble. However, everyone should have a battery hydrometer to test his battery.

Upon discharging the battery, let us assume that we are using a detector and one step of amplification. The two vacuum tubes used are drawing about two amperes between them. The battery has but sixty ampere hours of current; therefore $60 \div 2 = 30$ ampere hours. This means that we can only draw two amperes for thirty hours.

The battery is now fully discharged and must be recharged immediately. However, a battery of sixty ampere hours' capacity that has two amperes drawn out of it should never be discharged for more than twenty-five hours. This leaves some life in the battery, which lengthens the total life of it.

Hydrometer readings should be taken at least once every week and pure distilled water should be added to the solution at least once every week, so that the plates are always covered. The full charge hydrometer reading of a lead-acid cell should be between 1.250 and 1.300 and the battery should never be discharged below a hydrometer reading of 1.18. The lead-acid cell has a fully charged voltage of 2.2 volts and discharged voltage of 1.8 volts.

Another type of battery is the Edison cell battery. The positive or nickel plate consists of one or more perforated steel tubes, heavily nickel plated and filled with alternate layers of nickel hydroxide and pure metallic nickel in thin flakes. The

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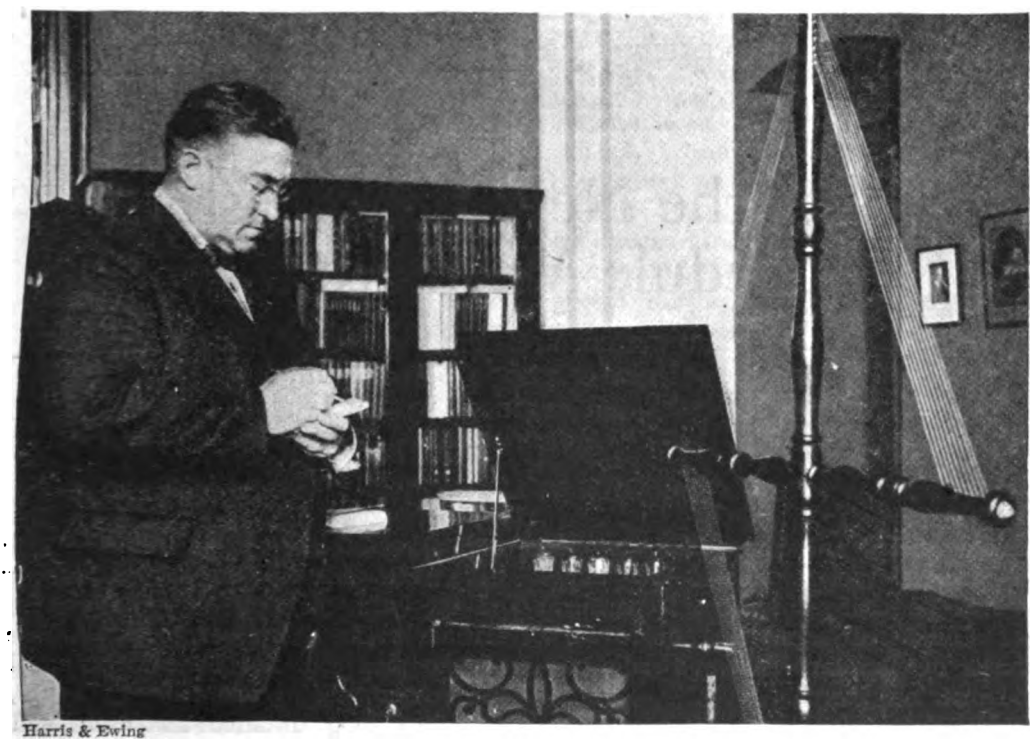
tube is drawn from a perforated ribbon of steel, nickel plated, and reinforced with eight steel bands, equidistant apart, which prevent the tube from expanding away from and breaking contact with its contents.

The negative or iron plate consists of a grid of cold rolled steel, nickel plated, that holds a number of rectangular pockets filled with powdered iron oxide. These pockets are made up of a finely perforated steel, nickel plated. After the pockets are filled, they are inserted in the grid and subjected to great pressure between dies which corrugate the surface of pockets and force them into good contact with the grid. The electrolyte consists of a 21 percent solution of potash in distilled water with a small percent of lithia. The density of the electrolyte does not change on charge or discharge. The Edison cell has a fully charged voltage of 1.2 volts and a discharge voltage of .9 volt. The Edison cell may be overcharged or over-discharged, or even short-circuited, without injury to the plates. The lead cell, if allowed to remain idle, will lose its charge, and if left in a discharged or a partially discharged condition for any length of time, deterioration of the plates will take place. The Edison cell will retain its charge for a long time and is not damaged by being left in a discharged condition.

Never leave your storage battery discharged for any length of time, and do not try to use it when it is run down, or it will become permanently injured.



Harris & Ewing

RADIO ENTERS CONGRESS

Just why Representative Louis T. McFadden of Pennsylvania should take upon himself the distinction of being the first member of Congress to install a receiving set in his workroom in the Capitol is made clear when it is known that he is chairman of the Banking and Currency Committee of the House. Were it not for the fact that Station WWX, operated by the U. S. Post Office, sends out the latest quotations, he would have to wait until they came lumbering in on the old-fashioned ticker!

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International

THE RADIO EXPERTS WHO FRAMED THE NEW RULES

The failure of the last Congress to pass the White Radio Bill prompted Secretary Hoover to re-assemble this National Radio Committee to work out new schedules to meet the emergency. And it did!

What the New Broadcasting Schedule Means to *You*

How order and system are being introduced into the ether and how interference is being eliminated, told by a nationally-known engineer who helped to frame the new rulings—

JOHN V. L. HOGAN

IF you are a broadcast listener, you have probably wondered how things would be changed by the Department of Commerce regulations made as a result of Secretary Hoover's radio conference last March.

You have read about the new wavelengths that have been opened to broadcasting, and about the new classification of stations. The changed rules went into effect on May 15; since then you have been able to find out something of the way the new organization of stations works. However, the real value of the plan will not be evident until the winter months are with us again, for then long distance reception will be free from summer-time static interference and wave absorption.

Perhaps the greatest change made by

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the use of extra wavelengths is in the reduction of interference between broadcasting stations.

To get some idea of this, can you imagine a great hall containing a dozen or two stages with bands playing on some of them, lecturers speaking from others and soloists performing on still others? Can you imagine yourself walking about such a huge auditorium, trying to enjoy the music of one orchestra, or the speech of one orator, amid the pandemonium created by all the rest? Can you conceive that anyone would try to provide instruction or amusement in this way for a building full of people? Certainly the only listeners who would hear anything satisfactorily would be those nearest each attraction, for by each of them this particular one would be heard louder than any of the others and to some extent would drown out the interfering sounds. People who were standing about equally distant from two bands, however, would not hear enough of either to be worth much; and persons located near one speaker would be entirely "out of luck" if they wanted to hear a man who was talking at the other end of the room.

If you will think of the United States as such a huge auditorium, each broadcasting station as a performer and each radio receiver as a listener, you will have a fair picture of the broadcasting situation as it was when Secretary Hoover called the National Radio Conference in Washington on March 20. The comparison is not exact, of course, but the fact is that on March 17 there were in the United States 560 broadcasting transmitters licensed to operate on the 833 kc.* per second (360 meter wave). This means that in so far as they worked at the same time, and at their official wave-frequency, they were all "in the same hall" and the only way to hear one to the exclusion of others was to move up near to it!

You realize, of course, that each wave-frequency (such as that of 833 kc.) represents a single path or channel for radio communication. As a practical matter, the channels cannot be narrowed down to a single frequency-value, and for radio telephony one must ordinarily have for each path or group or band of wave-frequencies about 10 kc. wide. Such frequency-bands are usually called by their central or *average* frequency, so that the one named 833 kc. really extends from 5 kc. less (828) to 5 kc. more (838). When a number of standard radio transmitters radiate waves of the same frequency, no receiver can select one station's signals from those of the others, no matter how sharply selective that receiver may be.

Thus broadcasting stations that use the same wave-frequency are almost literally in the same room, for no matter how carefully you tune your receiver you cannot discriminate between them except to the extent that the nearest and most powerful stations will be the loudest ones heard.

To help out the interference situation some forty of the best broadcasting stations were moved out of the

*The Second National Radio Conference, which met with Secretary Hoover in March, introduced a method of designating radio waves which is somewhat new to the radio public. This is the use of frequency in kilocycles (abbreviated kc.), instead of wavelength in meters. The frequency of the radio wave is the same as the frequency of the alternating current which flows in the radio transmitting or receiving set.

The reason that kilocycles have been adopted by the Department of Commerce is that the necessary separation of the frequency of transmitting stations to prevent interference is the same, no matter what the frequency may be. This necessary separation is variable and quite misleading when expressed in meters. Thus the number of radio messages that can be transmitted simultaneously without interference can be correctly judged from the kilocycles but not from the meters. For example, the amateurs will in the future work in a band of wavelengths from 150 to 200 meters, but this is a frequency band from 2,000 to 1,500 kilocycles. This is an enormously wider band when considered from the viewpoint of kilocycles than, for example, the band having the same width in meters from 1,000 to 1,050 meters, which is 300 to 286 kilocycles. While it is possible to carry on fifty simultaneous radio telephone communications between 150 and 200 meters, only one could be carried on between 1,000 and 1,050 meters.

To convert meters into kilocycles, divide 300,000 by the number of meters; to obtain meters from kilocycles, divide 300,000 by the number of kilocycles. For example, 100 meters = 3,000 kilocycles, 300 meters = 1,000 kilocycles, 1,000 meters = 300 kilocycles, 3,000 meters = 100 kilocycles.

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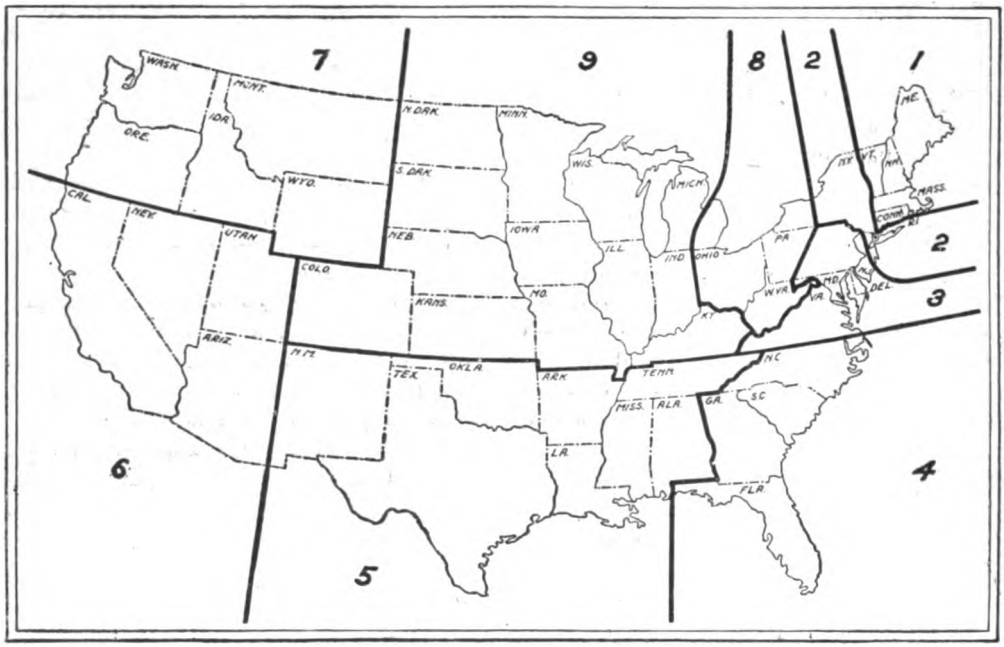

UNCLE SAM'S NINE RADIO DISTRICTS

The call letters of licensed amateurs are preceded by the numeral that indicates the district in which they are located. Thus "3ZY" would be located in the 3rd District.

general 833 kc. group and given a second wave-frequency of their own (750 kc., or 400 meters wavelength). This was more or less equivalent to putting these stations in a building of their own, where they would not be disturbed by the crowd of 833 kc. broadcasters. Nevertheless, even forty orchestras are too many for one building and forty powerful broadcasting stations are too many for one wave-frequency. To hear any one of them you must either move up near to the town in which it is located or else ask the other stations to keep still.

One may easily ask how such a chaotic and disorganized condition could have grown up in radio broadcasting, for it seems evident that only a relatively few stations could operate simultaneously at the same wave-frequency even though they were spread over so large a territory as the United States. The answer is not very simple, but perhaps the principal factor is that when the Department of Commerce decided to limit broadcasting to a single wave-frequency (or, in our figurative phrase, to "put all the stations in the same building") no one had any idea that so many people would want to broadcast.

For a time after the first few stations were licensed things went very well. KDKA at Pittsburgh did not interfere badly with WJZ at Newark or KYW at Chicago; it was only when two and three and even a dozen or more stations crowded into the same locality that real trouble developed. Even if the government authorities had realized the demands that broadcasting would make upon them they probably could have done little more than assign the two wave-frequencies that they did grant, namely 833 and 750 kc. (360 and 400 meters), for most of the other useful radio channels were already in use and could not easily be pre-empted for broadcasting.

The biggest job that the radio conference had before it was to find more

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wave-frequency bands for broadcasting. The government departments had the exclusive right to use a wide range of waves from 500 to 187 kc. (600 to 1,600 meters), and they were willing to throw open a part of it to other uses, but so few broadcast receivers would operate at wave-frequencies below 500 kc. that it would not have been fair to the listeners to have extended the waves in that direction. On the other hand, only few broadcast receivers can receive waves of frequencies higher than 1,500 kc., so that a similar upper limit was fixed at the corresponding wavelength of 200 meters.

The job of getting useful groups of wave-frequencies for broadcasting was done along with that of minimizing interference between various kinds of radio services, by clearing out (as far as possible) all non-broadcasting activities from the 500 to 1,500 kc. range. By international agreement, 500 kc. (600 meters) is a marine and aircraft radiotelegraph wave, and it is largely used for distress calls; 50 kc. had to be allowed to protect it from interference, so the lowest frequency that could be adopted for broadcasting was 550 kc. (545 meters wavelength). By arranging to stop the use of 667 kc. (450 meters) in ship telegraph traffic services between the hours of 7 and 11 P. M., and by transferring to other waves a number of stations whose services would not be handicapped by the change, the conference was able to get a practically unbroken range of broadcasting waves from 550 kc. up to 1,000 kc.

At 1,000 kc. (300 meters) there is another wave-frequency used for ship and aircraft services, but by agreeing to minimize transmission at this frequency it was possible to carry the broadcasting waves on up to 1,350 kc. (222 meters). Bearing in mind that wavebands 10 kc. wide are needed for ordinary radio telephony, it is clear that the range from 550 to 1,350 kc. allows something like eighty independent channels for broadcasting. This means that under the new plan eighty properly located broadcast stations could be operated simultaneously all day long without interference, whereas the old plan permitted only two stations to work under the same conditions.

In order to operate still more than eighty stations simultaneously, advantage was taken of the fact that many BX plants (as we may call broadcasting stations) have limited power. Two of the most powerful stations would hardly interfere with each other if one were on the Atlantic coast and the other on the Pacific, even though both used the same wave-frequency. Thus, and particularly among the lower powered stations, waves may be duplicated if the stations to which they are assigned have locations that are well-separated.

In following the recommendations of the conference the Department of Commerce has established three classes of BX stations.

Class A includes the low-powered group with a limited distance range; to this class the wave-frequencies from 1,050 kc. (286 meters) to 1,350 kc. (222 meters) have been assigned.

Class B covers the stations of 500 watts power or over, with strict requirements as to quality of program and transmission; the wave-frequencies from 550 kc. (546 meters) to 1,040 kc. (288 meters) are set aside for these high grade plants.

Class C, for the present, includes stations that will use the old 833 kc. frequency which lies about in the center of a reserved range of wave-frequencies from 800 kc. (375 meters) to 870 kc. (345 meters). Class C stations are those whose management desire to continue to use the old "360 meter" wave, regardless of whether they operate on high or low power.

The principles followed in assigning the Class B wavelengths are simple, but in themselves automatically min-

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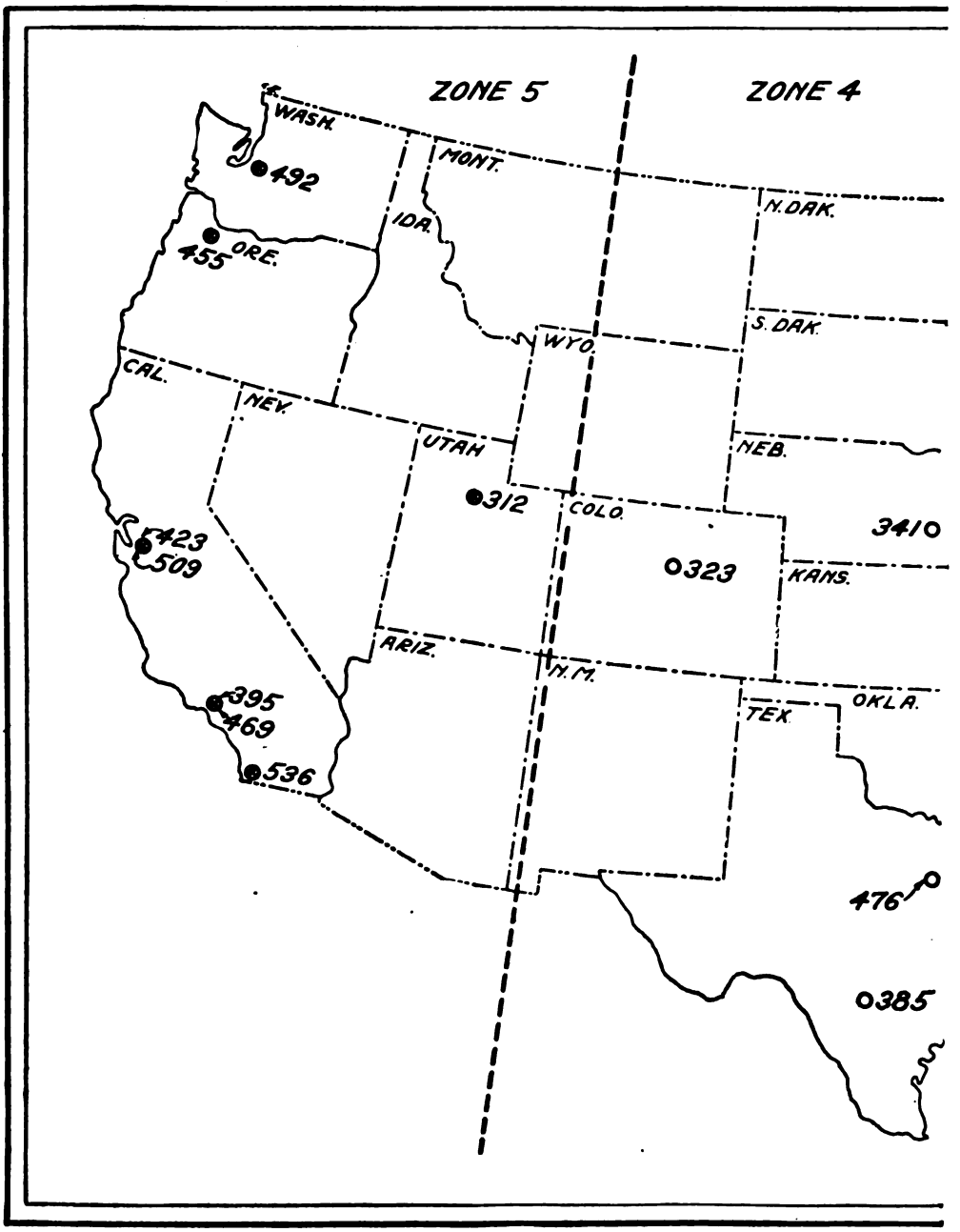

The Five New Broadcasting Zones of the United States—

To each of the five zones has been assigned ten of the wavebands which have been set aside for the Class B (high-powered) stations; the frequencies of any two stations within each zone have been kept at least 50 kilocycles apart.

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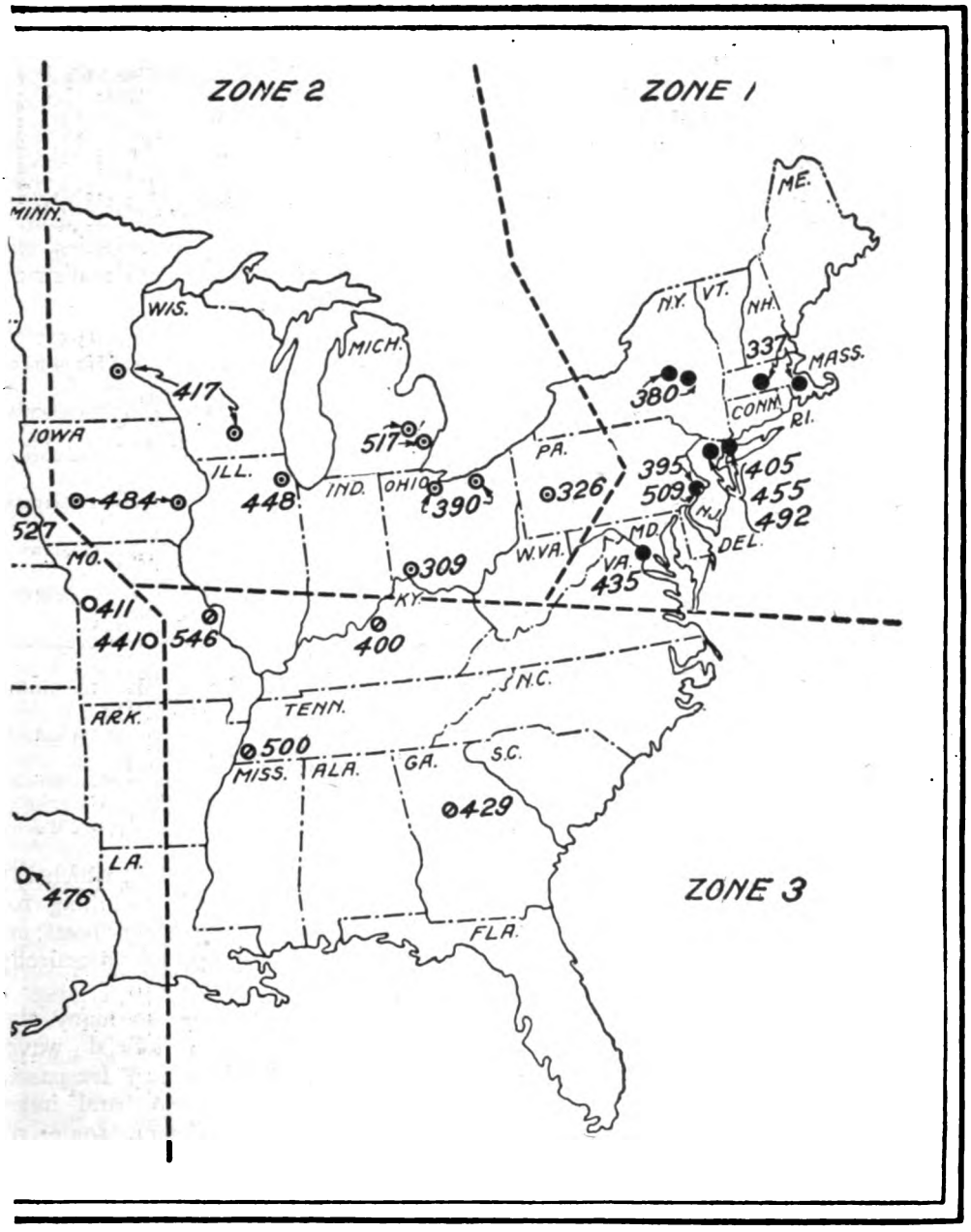

—and the New Wavelengths Assigned to the Leading Cities

The frequencies used by any two stations located in adjacent zones have also been separated by at least 20 kc. The remaining wavebands for the Class A (low-powered) stations will be distributed throughout the zones by the Radio District Inspectors.

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imize interference to a large extent. The United States is to be divided into five radio broadcasting zones; each zone is to be assigned ten of the fifty wavebands available for Class B stations. The frequencies of adjacent stations within any zone are to be at least 50 kc. apart, and the frequencies of stations in adjacent zones are to be at least 20 kc. apart. The remaining wavebands for class A stations are to be distributed among the radio inspection districts on a basis that will keep stations using each specific frequency as far apart (geographically) as may be possible.

The important Class B wavelengths and the localities to which they have been assigned are given in the following table, and those not reserved are shown on the accompanying map.

Frequency	Wavelength	Locality	Zone
550 kc.	546 meters	St. Louis, Mo.	3
560 kc.	536 meters	San Diego, Cal.	5
570 kc.	527 meters	Omaha, Neb.	4
580 kc.	517 meters	Dearborn and Detroit, Mich.	2
590 kc.	509 meters	San Francisco, Cal.	5
590 kc.	509 meters	Philadelphia, Pa.	1
600 kc.	500 meters	Memphis, Tenn.	3
610 kc.	492 meters	Seattle, Wash.	5
610 kc.	492 meters	New York, N. Y. and Newark, N. J.	1
620 kc.	484 meters	Davenport and Des Moines, Iowa	2
630 kc.	476 meters	Dallas and Fort Worth, Texas	4
640 kc.	469 meters	Los Angeles, Cal.	5
640 kc.	469 meters	*Reserved*	1
650 kc.	462 meters	*Reserved*	3
660 kc.	455 meters	Portland, Oregon	5
660 kc.	455 meters	New York, N. Y. and Newark, N. J.	1
670 kc.	448 meters	Chicago, Ill.	2
680 kc.	441 meters	Jefferson City, Mo.	4
690 kc.	435 meters	Washington, D. C.	1
700 kc.	429 meters	Atlanta, Ga.	3
710 kc.	423 meters	San Francisco, Cal.	5
720 kc.	417 meters	Madison, Wis. and Minneapolis, Minn.	2
730 kc.	411 meters	Kansas City, Mo.	4
740 kc.	405 meters	New York, N. Y. and Newark, N. J.	1
750 kc.	400 meters	Louisville, Ky.	3
760 kc.	395 meters	Los Angeles, Cal.	5
760 kc.	395 meters	Philadelphia, Pa.	1
770 kc.	390 meters	Cleveland and Toledo, Ohio	2
780 kc.	385 meters	San Antonio, Texas	4
790 kc.	380 meters	Schenectady and Troy, N. Y.	1
800 kc.	375 meters	*Reserved*	3
(810) kc.	(370) meters	*Reserved*	5
(820) kc.	(366) meters	*Reserved*	2
(830) kc.	(361) meters	*Reserved*	4
(840) kc.	(357) meters	*Reserved*	1
(850) kc.	(353) meters	*Reserved*	3
(860) kc.	(349) meters	*Reserved*	5
870 kc.	345 meters	*Reserved*	2
880 kc.	341 meters	Lincoln, Neb.	4
890 kc.	337 meters	Springfield and Wellesley Hills, Mass.	1
900 kc.	333 meters	*Reserved*	3
910 kc.	330 meters	*Reserved*	5
920 kc.	326 meters	Pittsburgh, Pa.	2
930 kc.	323 meters	Denver, Col.	4
940 kc.	319 meters	*Reserved*	1
950 kc.	316 meters	*Reserved*	3
960 kc.	312 meters	Salt Lake City, Utah	5
970 kc.	309 meters	Cincinnati, Ohio	2
980 kc.	306 meters	*Reserved*	4
990 kc.	303 meters	*Reserved*	1
1000 kc.	300 meters	*Reserved*	3
(1010) kc.	(297) meters	*Reserved*	5
(1020) kc.	(294) meters	*Reserved*	2
(1030) kc.	(291) meters	*Reserved*	4
(1040) kc.	(288) meters	*Reserved*	1

The Class A wave frequencies and their assignment to inspection districts are shown below:

Frequency	Wavelength	Locality
1350 kc.	222 meters	4th, 5th and 8th districts
1340 kc.	224 meters	All districts
1330 kc.	226 meters	All districts
1320 kc.	227 meters	1st, 6th and 9th districts
1310 kc.	229 meters	All districts
1300 kc.	231 meters	All districts
1290 kc.	233 meters	2nd, 5th and 7th districts
1280 kc.	234 meters	All districts
1270 kc.	236 meters	All districts
1260 kc.	238 meters	1st, 3rd and 6th districts
1250 kc.	240 meters	All districts
1240 kc.	242 meters	All districts
1230 kc.	244 meters	2nd, 4th and 9th districts
1220 kc.	246 meters	All districts
210 kc.	248 meters	All districts
200 kc.	250 meters	5th, 7th and 8th districts
1190 kc.	252 meters	All districts
1180 kc.	254 meters	All districts
1170 kc.	256 meters	1st, 3rd and 6th districts
1160 kc.	258 meters	All districts
1150 kc.	261 meters	All districts
1140 kc.	263 meters	2nd, 5th and 7th districts
1130 kc.	266 meters	All districts
1120 kc.	268 meters	All districts
1110 kc.	270 meters	4th, 7th and 8th districts
1100 kc.	273 meters	All districts
1090 kc.	275 meters	All districts
1080 kc.	278 meters	1st, 6th and 9th districts
1070 kc.	280 meters	All districts
1060 kc.	283 meters	All districts
1050 kc.	286 meters	3rd, 8th and 9th district

So much for the new plan, which has already proven itself a great thing for radio broadcasting. Whistling "beat" interference, for instance, has practically been eliminated.

It is not easy to keep so many stations exactly on their official wave-frequencies, and when one trespasses upon the neighboring waveband interference is created. Again, some receivers are incapable of selecting between wave-frequencies only 10 or 20 kc. apart, and users of such apparatus are having a little trouble.

Nothing, however, has come up or is likely to come up that will seriously interfere with the execution of the conference plan, and it is generally agreed that the new organization of wave-frequencies marks a great step in the advance of radio.

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ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

Radio "Dictation" for Students of Shorthand

THE latest difficulty that radio has done away with is the difficulty of the shorthand student to find someone patient enough to dictate to him. All he need do now is to plug in the headphones and copy down whatever is being broadcast.

* * *

Radio Equipment for the Fishing Fleet

Two hundred schooners of the French fishing fleet have been equipped with radio apparatus ranging from one-quarter to one kilowatt capacity.

* * *

Uncle Sam is Using Radio for Educational Purposes

THE U. S. Department of Education has set its stamp of approval on radio as a means for extension work. Twice a week, on Mondays and Thursdays at 6.45 P. M., it has lectures broadcast to listeners all over the country. Such subjects as the money value of education, visual aids to education, the necessity for education in a democracy, the economic loss due to illiteracy, have already been given.

* * *

Steel Skyscrapers Play Havoc with Radio Waves

ONE of the few obstacles that the ingenuity of radio engineers has not yet been able to surmount is the impossibility of radio transmission from the lower section of New York City due to the absorption or deflection of radio waves by the tall steel buildings. Two of the three stations on the island have not been able to operate successfully at all; even the third station experiences trouble in transmitting in certain directions.

* * *

A New Use for Antenna Towers

THE U. S. Navy Department has placed instruments on the top of one of the 700-foot towers of station NOF at Arlington, Va., to record wind direction and wind velocity for the purpose of obtaining data with which to direct airplane flights. Captive balloons were formerly used for this purpose but as these had to be brought down from time to time it was impossible to obtain continuous records.

Radio Unites Two Cousins

ANOTHER phase of radio's many services is indicated in the way station CFCA, Toronto, succeeded in re-uniting Walter Hales and Leonard Stanway, two cousins who had been separated for ten years. The two men came from England in 1913—Hales went to Massachusetts and Stanway to Toronto—and had been unable to locate each other since. Last winter Hales decided to try the help of radio and he asked CFCA to broadcast the following message: "Walter Hales of Orange, Massachusetts, is trying to locate his cousin, Leonard Stanway." This message was picked up by a friend of Stanway, and within a few days Hales received a letter from his cousin.

* * *

What France Demands of Radio Fans

IN France the amateur who wishes even a receiving set has to pay an annual fee of ten francs, promise to keep secret all intercepted messages, and agree to cease operations whenever the government so instructs.

* * *

A New Long-Distance Record for a Concert

STILL another record in long-distance broadcasting was set up by station WHAZ in Troy, N. Y., when the words and music of its radio concerts were heard distinctly on four successive nights by a station at Invercargill, New Zealand, which is nearly 10,000 miles away.

* * *

High-Speed Sending in the Army

RECENT experiments conducted by the Army have proved the possibility of clearing up the traffic jam at the Army Message Center in Washington by the use of transmitting machines that will send 100 or even 200 words a minute.

* * *

Reverse English by Radio

THOSE who had never heard English spoken backward were given an opportunity to do this recently when WGY broadcast part of a pallophotophone speech with the film reversed. The pallophotophone is an instrument used in connection with radio which photographs or records sound on a motion picture film—as described in POPULAR RADIO in February.

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Pilotless Planes for Future War

SOME indication of the spectacular part that radio is destined to play in warfare may be drawn from recent experiments at Etampes, France, with radio-controlled airplanes. The test flight was made with planes equipped with automatic stabilizers. While such aircraft may some day be utilized as bombers, it has been proposed to use them for the more peaceful purpose of transporting mail to Africa.

* * *

Radio Waves Check Crime Waves in China

THE radio service that now connects Peking with Tientsin has finally baffled the Chinese bandits who have been accustomed to make bullets out of the telephone wires that until recently have furnished the only line of communication between these cities. Until the oriental outlaws conceive of some way of converting radio waves into the munitions of banditry, the present system seems to be fairly immune from pillage.

* * *

The Radio Eyes of the Fleet

WHILE technical experts are arguing as to whether or not the gun elevations of the battleships of our first line fleet may be increased without violating the international agreement on armament, other experts point out that what is needed far more is an increase of radio-equipped airplanes. Not only would these be of great value against a fleet operating behind a smoke screen, but without them an increase of range would be no gain, since the limit of visibility for a rangefinder located in a fighting-top is eleven miles, or approximately the present range.

The World's Long Distance Amateur Record?

A NEW record in DX transmission was established when signals sent out by E. W. Rouse, station 5IM, Galveston, Texas, were picked up by a ship operator 100 miles south of Ceylon—and approximately 11,000 miles away—half way around the globe.

* * *

Germany's One Broadcasting Station

GERMANY boasts of only one radio broadcasting station. The service which it renders is extremely limited, moreover, owing to the fact that a license to own a receiving set in Germany costs $120—a price which is practically prohibitive.

* * *

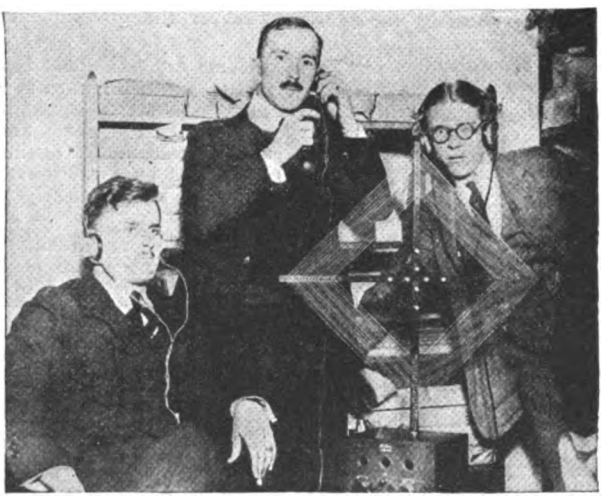
The Navy Helps Out on Commercial Radio Messages

ALTHOUGH the Navy is an important link in the U. S. radio chain about the world, it never competes with commercial stations. It handles commercial messages under careful restrictions at a rate not less than the commercial rate and only when its assistance is needed to maintain traffic. As soon as the Secretary of Commerce notifies a navy station that a commercial station is prepared to take over its work, the navy station withdraws its service.

* * *

Radio Gives Its Name to a Town

THE home of the Navy's powerful radio station NAA, commonly thought of as Arlington because of its location near the great National Cemetery, is registered in the *U. S. Postal Guide* as Radio, Virginia. It claims the honor of being the first town in the country to take its name from the popular art.



International

RADIO BREAKS INTO A SAFE

One of the most unusual tests to which radio has been submitted was held recently in Stamford, Conn., when officials of the Stamford Trust Company allowed themselves to be locked into the bank's safe, equipped with a complete receiving set. Through the steel and concrete walls, not only orchestra music from WJZ in Newark, N. J., but the voice of the announcer came in clearly.

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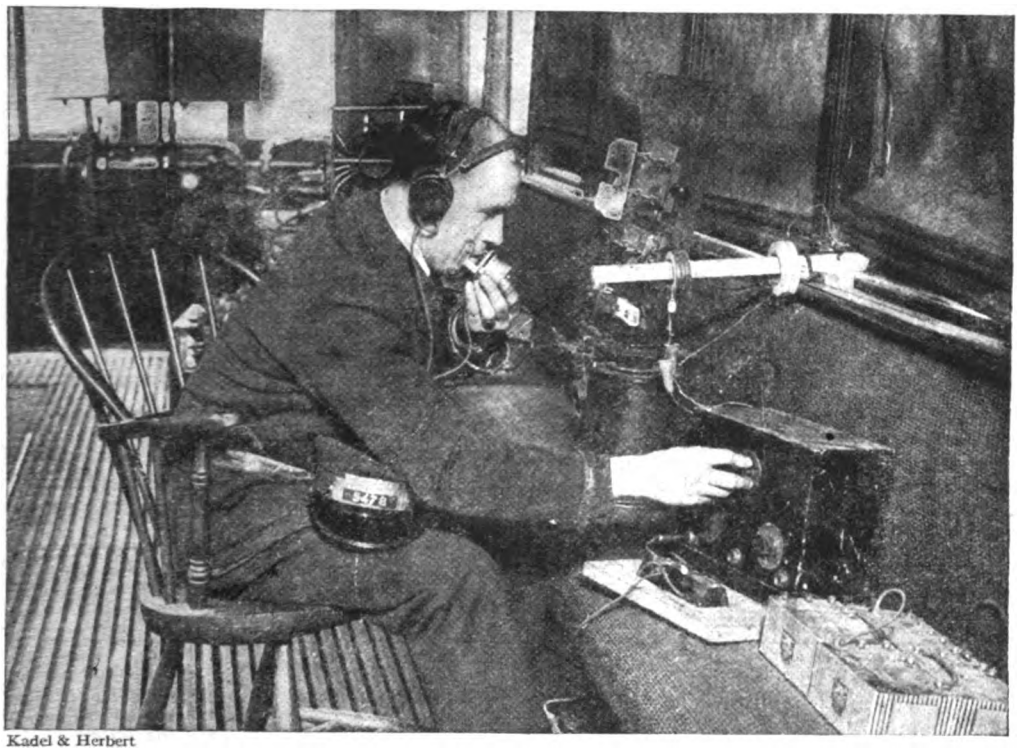

Kadel & Herbert

RADIO MESSAGES ON ELECTRIC CARS

Recent tests show that radio communication on carrier waves can be carried on successfully between central power stations and moving street cars. It is not improbable that trolley cars may be fitted with radio sets for use in case of emergency.

Why British Broadcasters Get Gray Hair

IN order to run a notice of their programs in the daily papers, British broadcasting stations are now obliged to buy the necessary space at regular advertising rates; it is calculated that to obtain adequate notice in this way costs a station about $500 a day.

* * *

Broadcasting Niagara Falls

THE harnessing of the human voice and of orchestral concerts are only the beginnings of radio's possibilities; one of the latest achievements to be recorded is the broadcasting of the voice of Niagara Falls. By placing a microphone in the deep recess of the famous Cave of the Winds, it is possible "to hear the mysterious rush and roar of Niagara, the subtle orchestration of infinitely shaded sounds."

* * *

Singing from Four Cities at the Same Time

WHEN Anna Case sang at the Metropolitan Opera House recently, her voice was broadcast from four radio stations at once—from WEAF in New York, WMAQ in Chicago, WGY in Schenectady and KDKA in Pittsburgh. Her voice was carried to the four microphones over the telephone wires, and was projected into the ether almost simultaneously.

A Room and a Bath—and a Radio

ONE of the largest hotels in Minneapolis has decided that it cannot honestly advertise as being equipped with "all the modern conveniences" unless it includes radio service. Three sets, therefore, have been installed in an upper story and each room is furnished with a connection to one of these sets. A guest only has to plug in to be given radio entertainment.

* * *

Ether Waves Among the Alps

THE latest nation to take up radio is Switzerland, where the manufacturers can hardly turn out instruments fast enough to keep up with the demand. The nearest important broadcasting station is the Eiffel Tower, 300 miles away, but with the Alpine summits to give height to their antennas, the Swiss do not find difficulty in receiving programs.

* * *

The Broadcasting Wave in South America

With the successful opening of broadcasting stations in Buenos Ayres, Montevideo, Rio de Janiero and other cities, radio enthusiasm in South America seems to have really come to stay. American dealers report that radio apparatus is being bought in all the countries; in Argentina alone there are 25,000 receiving sets as compared to approximately 100 a year ago.

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THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

¶ *In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry.*

QUESTION: I am getting wonderful "DX" on my four-circuit tuner right here in the city; I tune through the local stations and am having so much enjoyment out of the circuit that I want to take the set with me on my vacation. Would it be possible to use WD-11, WD-12, or UV-199 tubes in this set. I have no means of charging a storage battery in my country place and will have to use a dry-cell tube. Will you please let me know if these tubes can be used?

B. R. F.

ANSWER: These tubes function nicely in the circuit referred to, and any of them will give good results. You will need a "C" battery in the grid circuits of the amplifiers, however, to get maximum signals and clear modulation.

* * *

QUESTION: When I place my hand near the variable condenser in the antenna tuning circuit of my receiver I get a howl. When I tune in a distant station I have to place my hand a certain distance from the dial to keep it tuned in. If I move my hand or take it away the signals disappear and the howl comes back. Isn't there some way to overcome this trouble?

FRED S. HACKETT

ANSWER: Connect the rotary plates of the condenser in question to the wire that leads to the ground, and the stationary plates to the wire that leads to the antenna; your trouble should then be eliminated. In other words, reverse the connections to your condenser. This reduces the body capacity of the set by placing the shaft of the condenser at ground potential.

* * *

QUESTION: Should the grid leak be connected across the grid condenser or from the grid to the filament?

A. D. ROBERTS

ANSWER: In the majority of circuits the best results will be obtained if the grid condenser is connected from the grid direct to the filament.

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QUESTION: Is it possible to use radio frequency amplification with a crystal detector? I have a simple crystal set at present and have had such good results during the last winter that I hate to give up the crystal. Please tell me where I can obtain a hook-up that uses one bulb and the crystal.

HERBERT LANGDEN

ANSWER: On page 467, Figure 1, of the June issue of POPULAR RADIO you will find a circuit for using the tube and crystal in a simple reflex radio frequency set. It should give you loud signals.

* * *

QUESTION: I have heard much lately about the different ratios for amplifying transformers, but I am not really clear as to just how they should be used. Will you kindly tell me where the different ratios—10 to 1, 5 to 1, 3½ to 1 and so forth—should be used in the circuit?

S. RATHBERN

ANSWER: The high ratios should be used in the first stage of amplification and the lower ratios in the succeeding stages.

* * *

QUESTION: What resistance should be used in the rheostat for the new UV-199 tube? I have purchased three of these tubes and I would like to operate them all on the one rheostat. I am going to use two 1½-volt dry-cells in series for lighting the filament. Will you please let me know if this will be feasible, and if so what is the correct resistance to use?

A. C. DILLINGAST

ANSWER: This scheme is perfectly feasible. The rheostat for the three tubes should have a resistance of thirty ohms.

* * *

QUESTION: Will one stage of radio frequency amplification bring in signals when a loop antenna is used and the distance is fifty miles or less?

G. H. WAGNER

ANSWER: Yes, if a reliable detector is used with it. It will not operate a loudspeaker unless audio frequency amplification is added, however.

* * *

QUESTION: Will you show me how to add one stage of audio frequency amplification to my three-coil receiving set? I obtained the original hook-up from Figure 1 on page 59 in the May, 1922, issue of POPULAR RADIO.

HENRY S. AIRES

ANSWER: In Figure 1 you will find the complete circuit. The extra parts you will need are:

J1—double-circuit jack;
J2—single-circuit jack;
C—mica fixed condenser, .0005 mfd.;
R2—rheostat, 6 ohms;
AFT—audio frequency amplifying transformer;
extra "B" batteries;
tube socket.

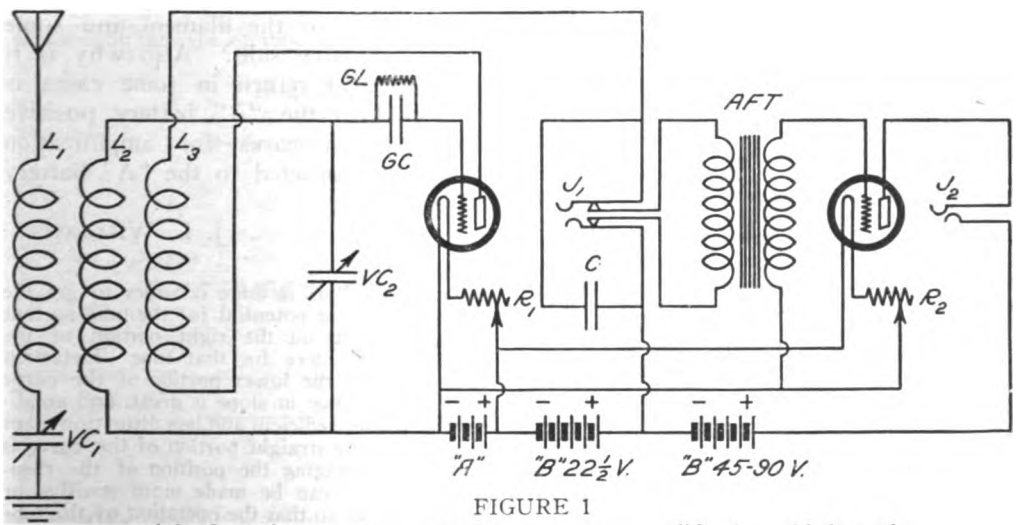

FIGURE 1

A hook-up for one stage of audio frequency amplification added to the triple-coil set.

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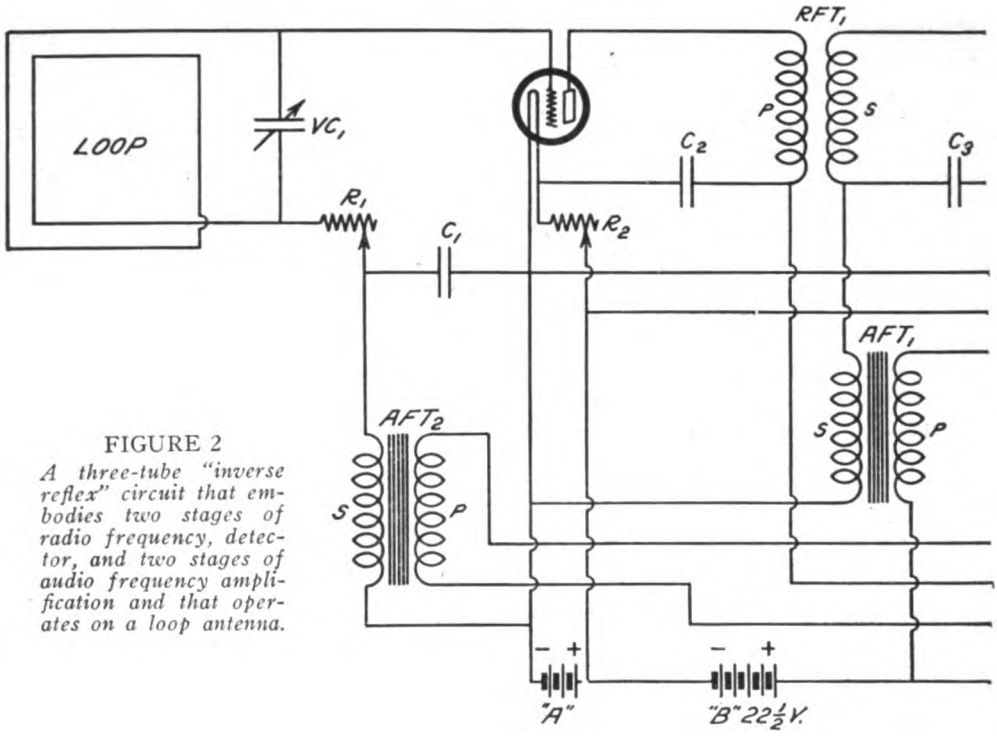

FIGURE 2

A three-tube "inverse reflex" circuit that embodies two stages of radio frequency, detector, and two stages of audio frequency amplification and that operates on a loop antenna.

QUESTION: Please give me the hook-up of the "inverse reflex" circuit for three tubes. Show the proper connections for a loop if it is possible to use one with this circuit.

FLOYD MURDIN

ANSWER: The circuit you need is given in Figure 2. The designations on this diagram refer to the following parts:

VC1—variable condenser, .0005 mfd.;
C1—fixed condenser, .0025 mfd.;
C2, C3, C4, and C5—fixed condensers, .001 mfd.;
RFT1 and RFT2—radio frequency amplifying transformers;
AFT1 and AFT2—audio frequency amplifying transformers;
R1—Variable resistance, 300 ohms;
R2, R3 and R4—filament rheostats;
GC—fixed condenser, .00025 mfd.;
GL—grid leak resistance, 2 megohms.

The "A" battery potential will depend on the type of tubes used and the "B" battery potentials are indicated on the diagram.

* * *

QUESTION: Is it good to stick the windings of a coil together with collodion? I have heard that shellac is harmful and thought that this might also apply to the collodion.

E. FRED KENNEDY

ANSWER: If you cover the windings with any kind of insulating paint or varnish it will increase the distributed capacity and this will interfere with the sharp tuning of the set. For best results leave the coils dry.

* * *

QUESTION: What is the reason that some tubes require the rheostat on the positive side of the filament and some on the negative side? Also why is it that the grid return in some cases is connected to the "A" battery positive and in most cases for amplification is shown connected to the "A" battery negative?

J. L. WILLIAMS

ANSWER: This is done in order to get the correct free grid potential for the tube so that it will operate on the right portion of the characteristic curve for that tube. Detection takes place at the lower portion of the curve where the change in slope is great, and amplification is more efficient and less distortion takes place when the straight portion of the curve is used. By changing the position of the rheostats the grid can be made more positive or more negative so that the operation of the tube will be shifted to the portion of the curve where the best results can be obtained.

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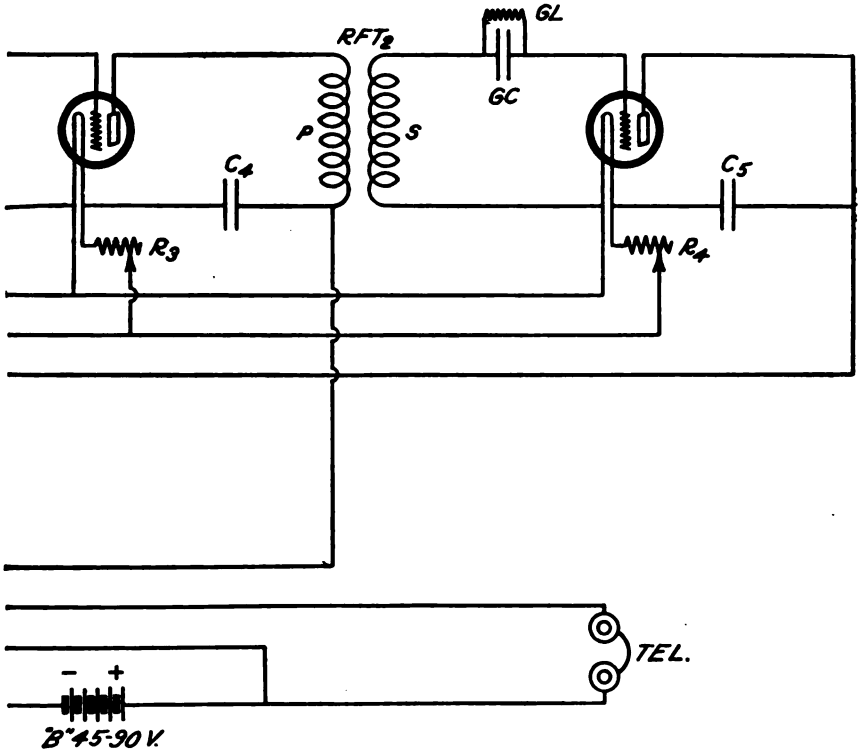

QUESTION: I want a hook-up that will show how to add one stage of amplification to my single-tube set. How many volts should be used on the plate?

ROBT. G. GIBSON

ANSWER: The circuit you need is shown in Figure 3. This amplification may be added to any set, whether it uses a crystal or a vacuum tube detector. The "B" battery you should use may be anything up to about 90 volts; it depends upon the type of tube you have on hand.

QUESTION: With four-circuit tuner described on page 358 of the May issue of POPULAR RADIO, would it be better to place the filament rheostats in the negative leg of the filaments rather than in the positive leg, if I use UV-201-A tubes for the amplifiers.

ANDREW SCOTT

ANSWER: When this type of tube is used for an amplifier this would be better; when it is used for a detector the rheostat should be left in the *positive* leg for best results.

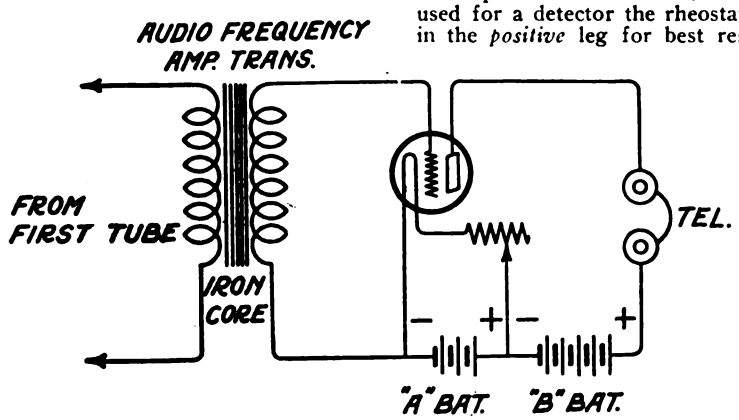

FIGURE 3

One stage of audio frequency amplification that can be added to any crystal or vacuum tube set.

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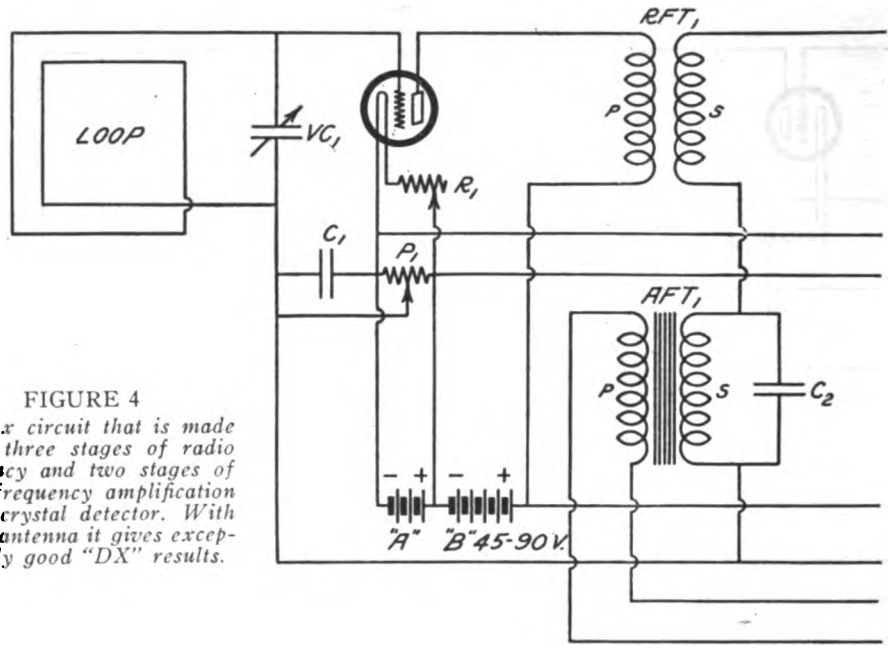

FIGURE 4

A reflex circuit that is made up of three stages of radio frequency and two stages of audio frequency amplification and a crystal detector. With a loop antenna it gives exceptionally good "DX" results.

QUESTION: Will you draw me a diagram of one of the most successful reflex circuits? I do not wish to use more than three tubes and a crystal detector, unless I can get much louder results by using additional tubes. Please include also a list of the parts necessary together with their constants.

RUSSELL KNIGHTON

ANSWER: A diagram for a three-tube and crystal detector circuit is shown in Figure 4. The parts for the set are:

VC1—variable condenser, .0005 mfd.;
C1—fixed condenser, .005 mfd.;
C2—fixed condenser, .0015 mfd.;
C3—fixed condenser, .0015 mfd.;
C4—fixed condenser, .0015 mfd.;
C5—fixed condenser, .002 mfd.;
C6—fixed condenser, .002 mfd.;
R1, R2, and R3—filament rheostats;
RFT1, RFT2, RFT3—radio frequency amplifying transformers;
AFT1, AFT2—audio frequency amplifying transformers;
DET—crystal detector.

A suitable loop antenna for this hook-up would be a spiral loop, three feet square, with the turns spaced ¼-inch apart.

* * *

QUESTION: When I wiggle my phone cords I hear a crackling sound. At first I thought that one of the terminals of the phones was loose, but upon investigating I find that they were connected properly. What is the trouble?

THOS. NELSON

ANSWER: The trouble is in your phone cords. Inside of the silk covering there are a few strands of braided tinsel and you have at some time pulled or twisted the cords so that these strands have broken through or they have worn out and now touch and separate when you move them. Get a new set of phone cords at the local dealer and connect them in place of the damaged ones.

* * *

QUESTION: How often should I have to charge my 6-volt, 60-ampere storage battery if I use it on a three-tube set, about three hours a night and four nights a week?

JOHN B. GRILLIN

ANSWER: If your tubes draw approximately one ampere per tube, the three tubes will take three ampere-hours an hour. For three hours a night, this will be nine ampere-hours an evening. For four nights this will be 36 ampere-hours. In this case your battery will need to be charged about once every two weeks.

* * *

QUESTION: Please send me a hook-up for the following parts:

1 Workrite variocoupler;
1 High-tone buzzer; } for
1 push button switch; } buzzer
1 dry-cell; } test

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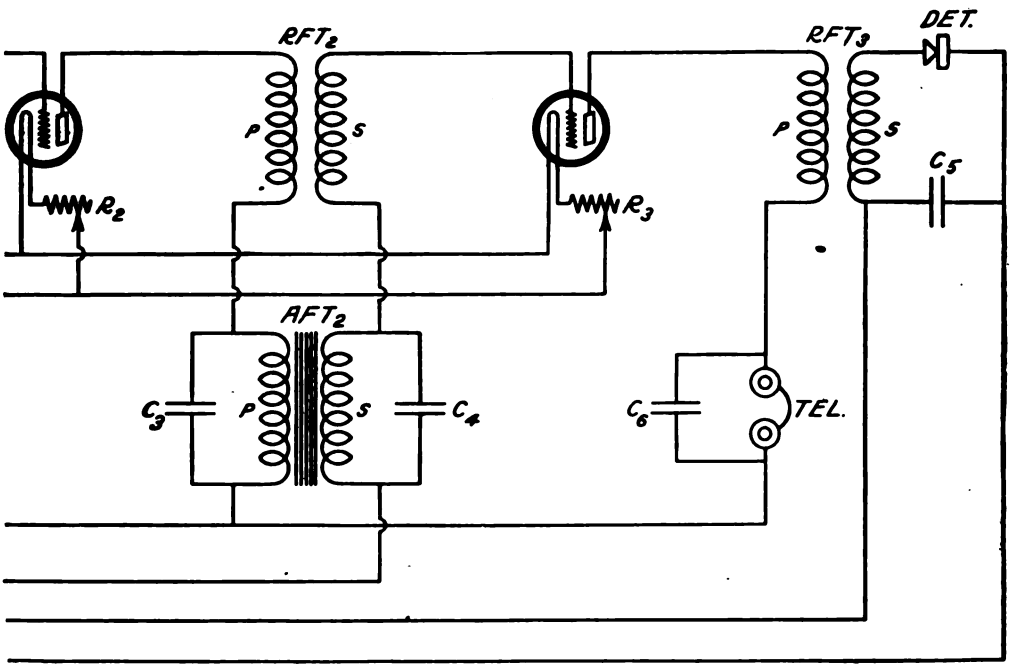

1 Micon condenser, .001 mfd.;
1 Amrad variometer;
1 Foote tested mineral detector;
1 pair Teleradio phones;
1 detector stand.

I would like to use all these parts if possible, as I wish to change the set to a vacuum tube circuit when I become more familiar with tuning.

A. GREENLEAF

ANSWER: A crystal circuit which employs the instruments you describe is shown in Figure 5. This set may be easily converted into a single-tube circuit by the addition of a variable condenser, a tube and tube socket, and a rheostat, grid condenser and grid leak.

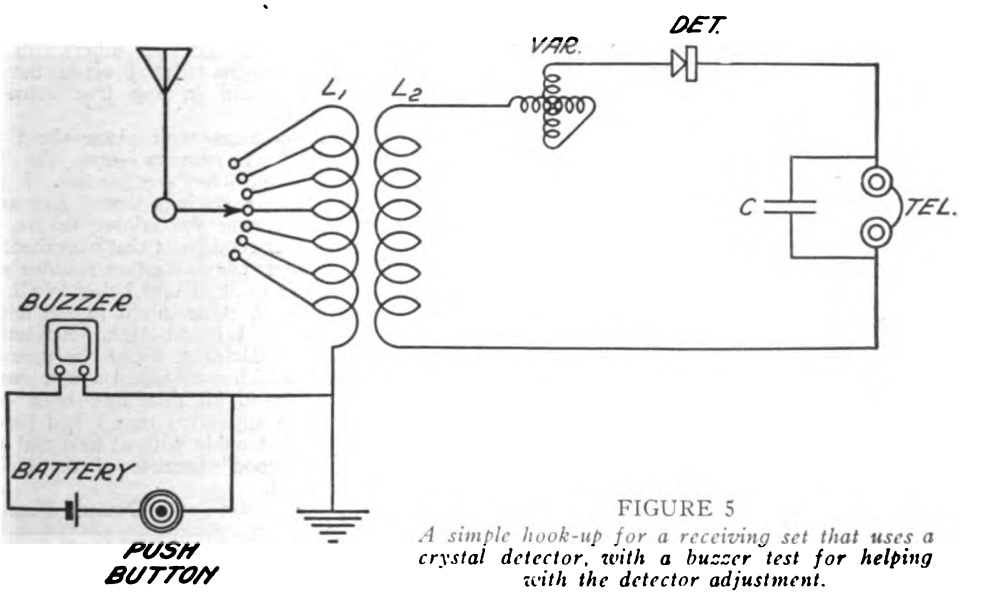

FIGURE 5

A simple hook-up for a receiving set that uses a crystal detector, with a buzzer test for helping with the detector adjustment.

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

An Indian Guyed by Radio

FROM the wilds of Quebec comes the following delightful acknowledgement of the joy with which radio is being hailed by the backwoodsman whose life has, up to now, been largely cut off from civilization. The letter was addressed to station WGY in Schenectady, New York, and is reproduced just as it was received:

i am gide for hunter man wot come at dis place Lac-des isle for hunting deer. dese hunter man bring it wit him a machine for heer you spik sunday nite also tuesday nite i hear song bout my old modder dats long tim i dont see my modder and i ting dats dame fine song also i heer oder song i dont no de nam. tuesday nite storie for de small boy and girl bout mak de star shine for dem if dey is good boy and girl. hunter man laff lik hell an tole me ax you how we make some moon shine.

i hear you spik just de same lik your at me place i ting you have good machine i lissen more nex week.

tank you and much oblige

gide Camille Poirier

Chemis p. o., Quebec, Canada

* * *

Experience Adds 1000 Miles to My Receiving Range

WHEN that new receiving set of yours is not coming up to expectations do not condemn it, do not be tempted to blame the dealer for selling you a poor set, but keep at it until you have secured the necessary familiarity with the tuning of your apparatus. The chances are that the trouble is not with your set, but with you—as this amateur in Ithaca, N. Y., confesses:

I shall probably remember for some time my first attempt to operate a vacuum tube circuit. Everything seemed hooked up all right, or so I thought, but when I lighted up the filament and prepared to listen, not a sound did I hear. My trouble, I soon found, was one familiar to novices, a "B" battery connected up in the wrong way; and after I had remedied this I was rewarded by signals from Arlington.

I soon tired of this straight audion hook-up, however, and passed on to the regenerative circuit. Then began more trouble. First, the bulb would not oscillate, but this difficulty was finally overcome and mediocre results were obtained within a comparatively short time.

Still there did not seem to be much to hear. For a long time I heard nothing but a few 600 meter stations; I could pick up no amateurs at all. Then one night I heard for the first time an amateur station located about five miles away, then one about fourteen miles distant, and later others still farther away came in. But I could not get stations that could in any true sense be called distant.

These experiences took place about two years ago. Last summer—not the best weather for radio by any means—I succeeded in getting stations that I had never thought of hearing the winter before, despite the poorer conditions that prevailed. A number of distant broadcasting stations were picked up, the most distant being WSB, the *Atlanta Journal*. One night in the middle of the summer I heard 5LA, an amateur station in New Orleans, about one thousand miles away, which established a new record for my set. And all this has been done with the same apparatus that I had experienced so much trouble with at first and pronounced "no good" because of the limited results secured.

L. DONALD KOONS

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A New and Remarkable Low-Amperage Vacuum Tube

HERE is a description of what may be regarded as one of the most important developments of vacuum tube construction of the past year:

One of the recent developments in vacuum tube construction is the new UV-199 which consumes 70 percent less current than any of the small or so-called "peanut-tube" variety. It operates with the filament current supplied from an ordinary flashlight battery.

This new type tube has the X-L tungsten filament, which according to radio engineers is considered as great an advance over the old tungsten filament for vacuum tubes in radio work as the tungsten incandescent lamp is over the carbon lamp in the field of electrical illumination.

The filament wire in the new tube is exceedingly small. It is but one-fourth the diameter of an ordinary hair. However, this is not an indication of any weakness for this tungsten wire has the strength of the best steel piano wire.

The filament of this tube consumes .18 watt, or approximately 1/27 of the energy used in the UV-201 tube. Yet the characteristics when used in a radio set are, if anything, slightly better.

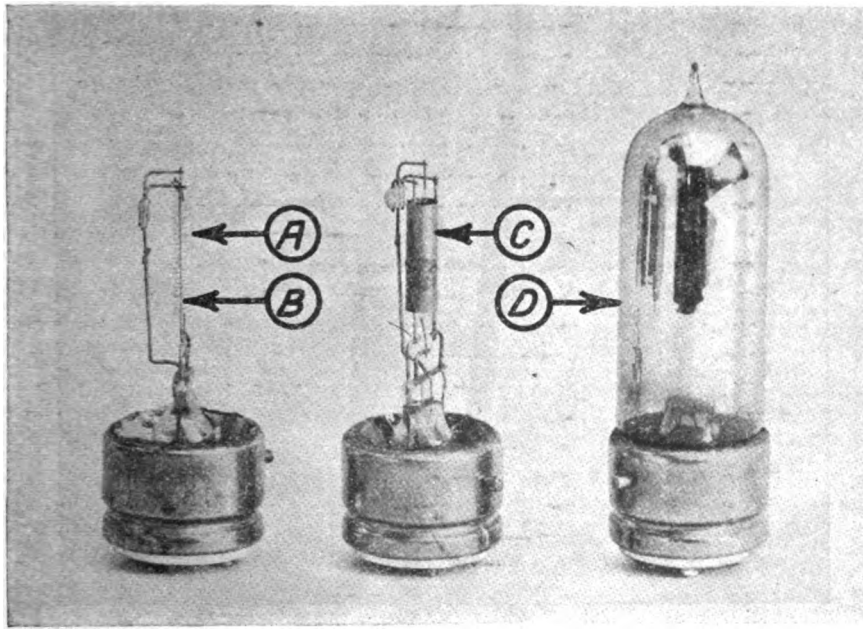
It is interesting to note that more than fourteen different chemical elements are utilized in this tube.

This new radiotron tube is an excellent radio frequency amplifier, because the capacity between elements is lower than that of the UV-201-A tube. It operates satisfactorily in all circuits which were used with the old UV-201 tube and should give slightly superior results, especially in radio frequency amplification.

The UV-199 tube requires so little filament energy that the ordinary No. 6 dry-cells give remarkably long service. For instance, three No. 6 dry-cells in series will operate one of the UV-199 tubes one hour a day for a whole year.

It should be understood that this UV-199 tube will not deliver as much energy as an amplifier that the UV-201-A will. The UV-201-A is a remarkably powerful tube and has electron emission, mutual conductance and amplification far above any other receiving tube. It must not be expected that with a filament expenditure of only .18 watt that as powerful results can be obtained as an amplifier as with the expenditure of 1.25 watts.

On account of the low filament current required by this tube it is essential to have the filament rheostat of sufficient resistance. For operation from three dry-cells, the filament rheostat resistance should be at least thirty ohms per tube. If a six-volt storage battery is used, the resistance should be at least sixty ohms. In multi-tube sets the sockets for the



General Electric

THE CONSTRUCTION OF THE NEW TUBE

A is the tiny spiral grid, B the thoriated filament, C the cylindrical plate, and D the necessary glass bulb. Although this tube requires only .06 ampere, in its operating characteristics it is not a "peanut" tube.

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tubes should be cushion mounted so as to minimize the effect of vibration. This is necessary where more than one tube is used. The tube sockets may be set on small pieces of sponge-rubber and in this way all microphonic noises will be eliminated.

C. L. BEACH

* * *

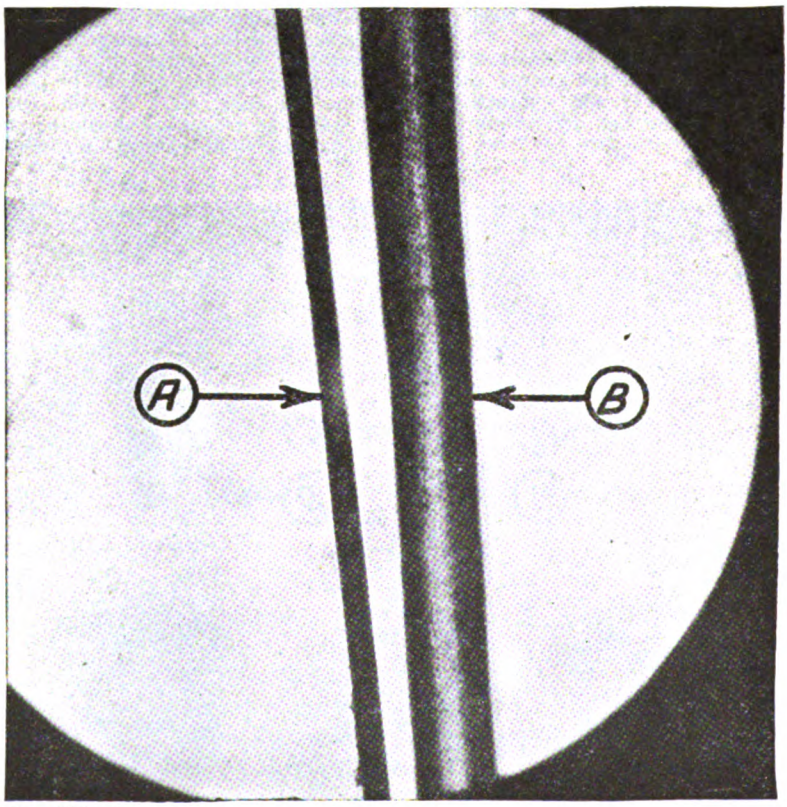
How Broadcasting Affects the Artist

THE nervous strain of broadcasting is a factor with which the inexperienced artist does not always reckon. Some idea of it may be derived from the following item which comes to us from a man who has had a great deal of experience both with artists and with broadcasting:

As everyone knows, the radio apparatus is so sensitive that the slightest sounds are conveyed and amplified to an appreciable degree of intensity, so much so that anything extraneous to the actual broadcasting event is most likely to spoil the result. Therefore, silence is imposed upon all in the studio while broadcasting is in progress. Silence is difficult to maintain for any period and when so required constitutes an additional strain upon the nervous system—the very thought that you must not make a sound other than to sing or play; that you must make no movement unless it can be accomplished silently; that you cannot clear your throat, ask for a sip of water, whisper, blow your nose or even breathe deeply. This kind of silence is more awful than darkness, just as a lull before a storm is more impressive than the storm itself. Tension engendered by absolute repose is a severe strain. Broadcasting enjoins these two unnatural factors upon the artist.

Silence and an invisible audience compose a two-handed encumbrance that requires a very robust temperament to overcome.

C. E. LE MASSENA



General Electric

HOW THE FILAMENT OF THE NEW TUBE COMPARES WITH A HUMAN HAIR

In this greatly magnified picture A is the filament (made of the new thoriated metal described in the June issue of POPULAR RADIO*), and B an ordinary human hair. In spite of its small size, the filament is as strong as the best piano wire.*

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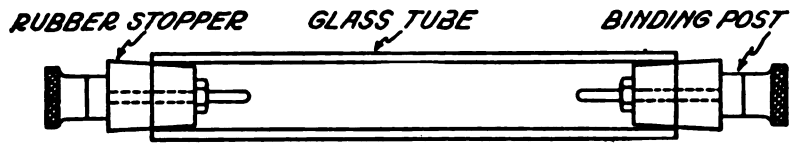

A POLARITY INDICATOR THAT YOU CAN MAKE YOURSELF

FIGURE 1: *The container for the liquid. The only parts required are a glass tube, stoppers, binding posts, screws and nuts—which cost about 25 cents.*

The Nuisance of a Single-Circuit Regenerative Receiver

EVERYBODY who has listened in on a radio set is familiar with the buzzing, whistling and squawking that so generally interferes with broadcasting reception. This exasperating nuisance was injected into the radio game by the single-circuit regenerative receiver, which was placed on the American market for novices because it was so easy to tune. The annoyance from this source is beginning to arouse serious protest. For example:

The trouble with the single-circuit regenerative receiver lies in the fact that it is almost as good a transmitter as it is a receiver when it is in an oscillating state. When it is used with one bulb, it is hard for the operator to tell when the set is tuned exactly on the wavelength of a station that is being received; it is also difficult to determine when the set is oscillating. It may be set too near the oscillating point; when this is done all the listeners located in the vicinity are disturbed.

Much of the blame which has been thrown at the transmitting amateur for breaking up concerts has been directly traced back to the complainants themselves. It has been found that the latter were using single-circuit receivers, and it is well known that this type of receiver does not tune sharply. Such a set may be tuned to a wavelength of 3,000 to 4,000 meters yet the amateur directly on 200 meters will still interfere. The trouble lies not with the amateur but with this receiver. If a two-circuit receiver is substituted the amateur transmitting is easily tuned out.

In England, the use of American radio apparatus is prohibited for the express purpose of keeping out of the country what is frankly termed "the single-circuit menace." No single-circuit sets are allowed in that country; anyone who uses any type of set that re-radiates is legally liable, and will soon run into trouble with the Post Office authorities.

It seems to me that American manufacturers of radio apparatus should see the handwriting on the wall and eliminate this apparatus which is injuring radio broadcasting so much. I should think that they would be farsighted enough to realize that they would be able to see that although they make a little more money at first making and selling this cheap and simple apparatus, they are doing themselves harm in the long run by getting people disgusted with radio.

Needless to say that the amateur will not use this type of apparatus; he terms it "junk."

FREDERICK SIEMENS

* * *

How to Make a Polarity Indicator for a Few Cents

THE radio amateur who finds difficulty in determining the positive and the negative poles of a battery that is not marked, will be interested in the following instructions for making a polarity indicator; they come to us from a fan in England:

Get from any drug store small amounts of sodium sulphate and of phenolphthalein. Into a cup half full of warm water put as much of the sodium sulphate as will cover a silver dollar and as much of the phenolphthalein as will cover a dime. Stir until the chemicals are dissolved.

To try this mixture, place your charging wires into it (about 1½ inches apart). The negative wire should turn the surrounding liquid a reddish color. Shake the liquid and the color will disappear at once.

Now put in it two wires from your "A" battery and add a little of each chemical until the mixture is sensitive enough to be discolored by the negative wire as before.

Then you are ready to make the container shown in Figure 1.

Obtain a glass tube about three inches long and two rubber stoppers to fit it. Put the stoppers in each end of the tube and thread screws through them to project ¼ inch on the inside. Put a nut on the inside of each screw, and a nut and an extra terminal nut for connections on the outside.

When this has been done, fill the tube with the liquid, leaving a small air space so that it can be shaken to dispel the color.

Paper that indicates polarity can be made by immersing some blotting paper in the liquid. To use this, wet the paper with your finger and place the wires on it about ½-inch apart. The negative wire will make a red mark.

W. MILLAR

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The Fallacy That "Re-radiation" Aids Reception

THE opinion advanced by the Technical Editor on page 231 of the March issue of POPULAR RADIO, to the effect that the remarkable "DX" records established by sets that used only a crystal detector were not due to re-radiation from a vacuum tube set in the neighborhood but were straight cases of reception, has been given almost word-for-word confirmation by Dr. Greenleaf W. Pickard, the noted inventor, in a letter to Mr. Lloyd C. Greene. Dr. Pickard says:

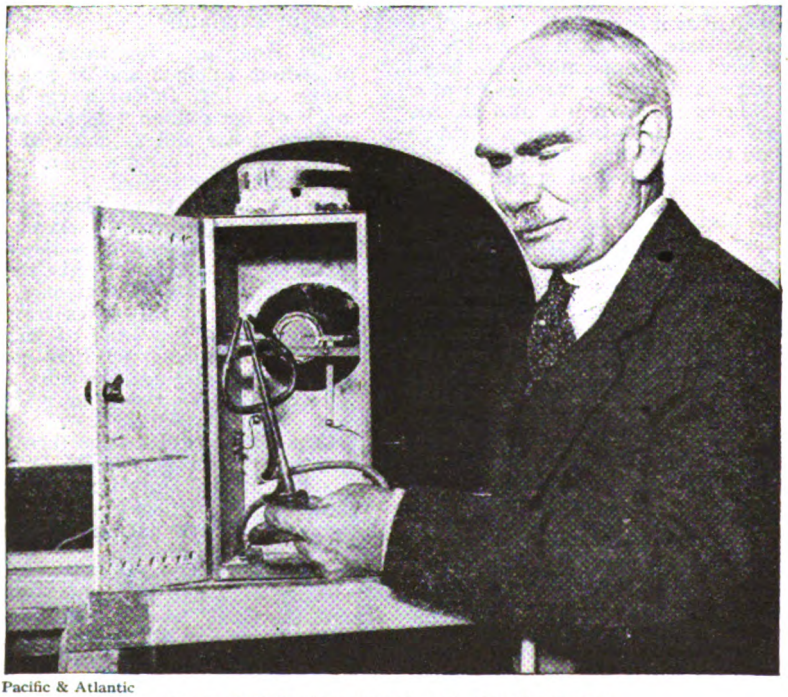
Wave trains from a distant broadcasting station pass the receiving antenna and as a result a varying electrical field exists in its vicinity. This field induces a current in the antenna and the current in turn produces a field around the conductor which is out-of-phase with the signal wave. The resultant field around the antenna, which is a sum of the field in the wave and in the current around the antenna, is always less than that of the signal wave.

If the impedance of the receiving antenna is lowered by an increase in regeneration, the current in the antenna and consequently the electric field around it will increase, but the resultant field will still further decrease.

If regeneration is increased until the effective resistance of the antenna is zero, the field due to the current in the antenna will exactly equal the wave field and will be 180 degrees out-of-phase from it. The field that results in the immediate neighborhood of the conductor, therefore, will fall to zero and reception will be materially weakened.

If regeneration is increased to such an extent that effective resistance is less than nothing—if it has, in other words, a negative value—oscillations will be produced and the field around the antenna may have greater values than the wave field of the signal. But in that case they represent an unmodulated field and they produce only the all-too-well-known squeal.

In a large measure especially good crystal reception is due simply to a good antenna, a good location, and efficient tuning. It is due also, of course, to the high grade of transmission that sometimes is given, particularly on winter nights.



Pacific & Atlantic

THE NEW "FLAME" TRANSMITTER

A microphone device without a metallic diaphragm which, according to its inventor, Dr. Lee De Forest, whose earliest experiments dealt with the sensitivity of a gas flame to sound and to electrical waves, gives almost perfect reproduction.

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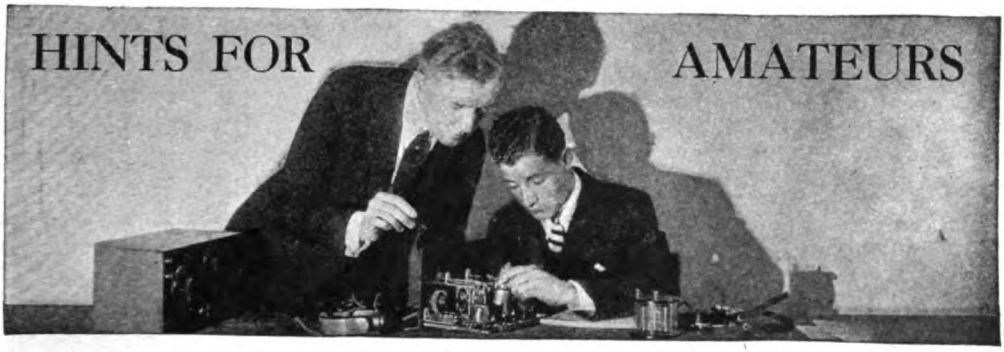

MANY radio amateurs live in a district where the house-lighting power is direct current. For these the charging of the radio storage batteries presents a troublesome problem, because the ordinary battery charger (which works on alternating current) is useless.

There are two ways to keep the battery charged. One way is to take the battery to a garage and have it charged. But this takes a couple of days, during which time the radio set is out of commission. The other way, which is simple, is to make a charging resistance out of a bank of lamps and connect the battery to the 110-volt *direct current* lines.

A circuit for connecting up your battery to the direct current lines, in series with a bank of six 32-candlepower carbon filament lamps, is shown in Figure 1. The two leads marked + and — should be connected to the lighting lines of the same polarity by means of a lamp socket and plug. It is *extremely important* that the positive wire of the lighting lines be connected through the lamps to the positive terminal of the storage battery.

To determine the polarity of the lighting line it would be well to procure a polarity indicator from the electrician. This costs but little and it will eliminate any possibility of mistake, and therefore protect your storage battery from harm.

* * *

A VERNIER rheostat when attached to a detector tube of a regenerative receiver will be a great help for tuning in long-

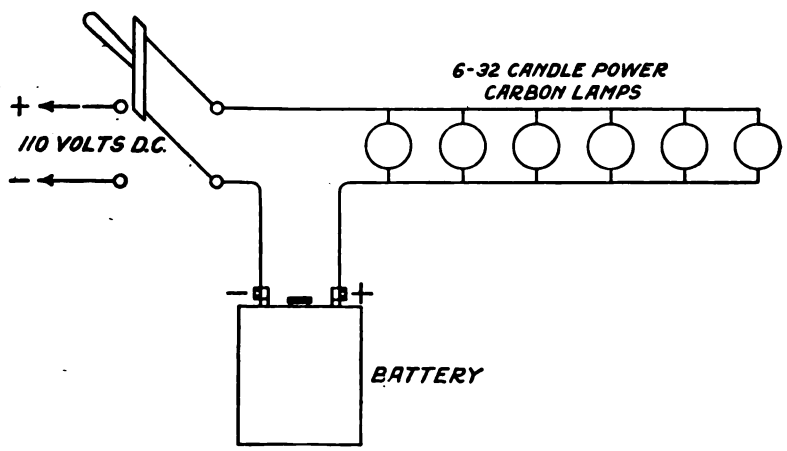

FIGURE 1

How a bank of six carbon lamps should be connected in series with the 110-volt direct current lighting lines to make a storage battery charging resistance.

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distance stations. There is no particular advantage in using it on amplifier tubes, as it will not help in the adjustment.

* * *

WHEN building a new radio set of a type that the builder is not familiar with, it is advisable to obtain the necessary instruments and parts and first set them up on a table, and connect them up and learn how to operate the circuit, before going about designing a cabinet for the set. In this way the amateur builder will familiarize himself with the scheme of the set, at least enough to know how to place the different parts so that the set will operate efficiently. Otherwise, serious mistakes may be made in design of the panel or the arrangement of the apparatus that would mean rebuilding the set in order to get the most out of it, and this costs money. This is another case where "An ounce of prevention is worth a pound of cure."

* * *

WHEN disconnecting a radio set take off the connections *at the batteries* first. If the wires are taken off in the set itself, they may touch each other accidently and ruin the batteries, whereas if the wires are taken off at the batteries there can be no possibility of a short-circuit.

* * *

THE average radio fan can get more thrills and enjoyment out of a small 5-watt C. W. transmitter than from all the receiving sets in the world. Get one or make one and then learn the code and see for yourself.

* * *

RECEIVING sets that are located close to powerful broadcasting stations often cannot tune out the nearby station and tune in stations which are at a greater distance.

For sets in such a location a wavetrap will be of great assistance in obtaining the sharper tuning which is necessary to accomplish this end. A circuit diagram is shown in Figure 2, which indicates the manner of connecting the wavetrap in series with the antenna circuit. The trap consists of a 35-turn duolateral coil shunted by a variable condenser of .0005 mfd. capacity. The trap is also shunted by a switch which may be closed when the trap is not needed. The switch should be open when the trap is in use while the local broadcasting station is in operation.

The set is tuned in the usual manner and the variable condenser of the trap is rotated until the point is found at which the interfering station is eliminated.

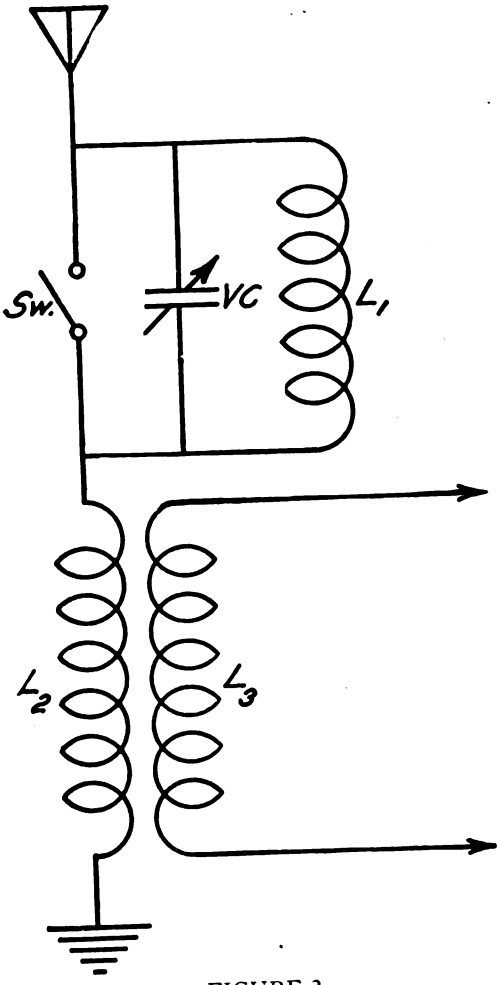

FIGURE 2

A simple wavetrap that, when connected in series with the antenna circuit of your receiving set, will enable you to tune out nearby interfering stations.

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IF *you are getting good results with your receiving set, tell your fellow-readers of* POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

A TRANSATLANTIC PASSAGE ON THREE YANKEE TUBES

WITH an American set and three American tubes, Henry Field in Leicestershire, England, hears three American stations. He uses an antenna 100 feet long and 45 feet high. The stations he hears are WJZ of Newark, N. J., WGY of Schenectady, N. Y., and WIP of Philadelphia, Pa. He writes:

"I have received WJZ fairly consistently, but the chief difficulty is that it fades about once every three minutes and the interference over here from the large commercial stations is bad. I have heard parts of concerts, time signals, weather reports and dance music programs."

* * *

A 2,100 MILE VOYAGE ON ONE TUBE

ONE dry-cell tube in a single-circuit hook-up covers 2,100 miles for Oren Pollock of Lampasas, Tex.; his record reception is WGY, Schenectady, N. Y. He uses a variocoupler with a spider-web rotor, a 43-plate condenser, and an antenna 90 feet long and 30 feet high.

Other stations on his list are WOC, Davenport, Ia.; WHM, New York City; WLW, Cincinnati, O.; WWJ, Detroit, Mich.; KZN, Salt Lake, Utah; WHAS, Louisville, Ky.; PWX, Havana, Cuba and WMC, Memphis, Tenn.

* * *

HE HEARS 81 STATIONS ON A $11.50 SET

WITH a three-tube set made from parts bought in a 10-cent store, Robert W. Carson hears eighty-one stations at his home in Indianapolis, Ind. By purchasing his tubes and transformers second-hand, he cut the total cost of his set to $11.50. His "B" battery is homemade. He employs the single-circuit principle with an antenna 80 feet long and 35 feet high.

Within eight minutes he has heard call letters announced from WBZ, Springfield, Mass.; KHJ, Los Angeles, Cal., and CFAC, Calgary, Can.

TO THE PACIFIC ON A REINARTZ CIRCUIT

ONE tube in a Reinartz hook-up frequently spans the continent for Edward J. Benesch of New York City. He has heard KFU, Gridley, Cal., about every other night; KFI, Los Angeles, Cal., three times for a half hour each time, and PWX, Havana, Cuba, twice for periods of 20 minutes. Some of his "old reliables," which he hears every night are WBAP, Fort Worth, Tex.; WDAF, Kansas City, Mo.; WSB, Atlanta, Ga.; WDAP, Chicago, Ill.; WOC, Davenport, Ia.; WLK, Indianapolis, Ind.; WJAX, Cleveland, O., and CFCA, Toronto, Canada.

His antenna is one wire 115 feet long, with a lead-in of 75 feet. He attributes his success to the length of his antenna, a good ground contact, and three weeks of constant experimenting with his tuning instruments. He is constantly finding new stations and he believes that with more careful manipulation of his dials he will continue to better his records.

* * *

THE FOUR-CIRCUIT TUNER TAKES HIM TO DENVER THE FIRST WEEK

WITH the four-circuit tuner described in the May issue of POPULAR RADIO, it took Russel P. May of New York City just about a week to bring in KDYW, Denver, Colorado, on his loudspeaker.

"It was only a question of learning how to tune the set," he writes; "when I *really* learn how to tune I expect to move in the best European circles."

May uses a single-wire antenna which is about 85 feet long. It runs from a chimney about 40 feet high to a grape arbor twelve feet high.

Other stations he hears are KYW and WDAP, Chicago; WBAP, Ft. Worth, Texas; WOS, Jefferson City, Missouri; WMC, Memphis, Tennessee, and PWX, Havana, Cuba.

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SIXTY STATIONS ON A LOOP

A LOOP antenna with six tubes brings in 60 stations for W. W. Roberts of Norfolk, Va. He hears KHJ of Los Angeles, Calif.; KOP of Detroit, Mich.; WNAC of Boston, Mass.; WKAQ of San Juan, Porto Rico; PWX of Havana, Cuba; CKAC of Montreal, Canada; WOAI of San Antonio, Tex., and practically all of the nearer high-powered stations of the United States.

His loop is of the flat type, with ten turns of No. 18 flexible lamp cord, stranded and insulated, making a total length of 120 feet. Storage battery tubes are used throughout, a detector, three stages of radio frequency amplification and two stages of audio frequency.

* * *

HE RECEIVES THROUGH STEEL WALLS

ALTHOUGH he is on the second floor of a steel and concrete apartment house and is surrounded for several blocks by large steel buildings, W. M. Batts of New York City hears stations as distant as WFAA of Dallas, Tex.; WOC of Davenport, Ia.; WMAQ of Chicago; WSB of Atlanta, Ga.; WNAC of Boston, Mass., and PWX of Havana, Cuba.

A loop antenna composed of five turns of No. 16 copper wire in the form of a four-foot square is used with six tubes, detector, three stages of radio frequency amplification and two stages of audio frequency. A 43-plate condenser across the loop serves as a delicate tuning instrument. The amplifiers use a 67½-volt "B" battery.

* * *

96 STATIONS ON THREE TUBES

USING a De Forest MR-6 receiving set with a C-300 detector, a C-301 tube in the first stage of audio frequency amplification and a W. E. VT-2 in the second, 96 stations have been picked up clearly by Henry K. Jarrett of Boyertown, Pa. He hears practically all of the large eastern stations and those as far west as the Rockies.

* * *

HE HEARS ALL THE LARGE STATIONS WITH FOUR TUBES

JACK BELL of Detroit, Mich., uses three stages of audio frequency amplification to receive from over 2,000 miles away, and hears all the large stations of North America.

"I use an antenna of one wire, 75 feet long and 35 feet high, and get better results than I did with my old four-strand antenna," he says, and jots down a few of his records, the best of which are KFI and KHJ of Los Angeles, Calif.; WAAB, New Orleans, La.; WDAJ, College Park Ga.; PW Havana, Cuba; WBZ, Springfield, Mass.; WEAF, New York City; WAOI, San Antonio, Tex., and KDZQ, Denver, Colo.

He uses the Armstrong regenerative hook-up and grounds his set on a steam radiator.

* * *

ONE DRY-CELL TUBE BRINGS IN DX

ONE dry-cell tube covers half the country for Adrian Todd of Philadelphia, Pa. A variometer is placed in the antenna circuit with a variable condenser of 23 plates in series with it. The secret of the hook-up lies in the grid circuit; the terminals of the variometer are connected to the grid and the plate instead of to the grid and the filament. A variable grid leak and a condenser are used between the grid and the variometer. The plate circuit is connected in the usual way.

Todd hears WOC, Davenport, Ia.; WDAP, Chicago; KYW, Chicago; WJAX, Cleveland, O.; WLW, Cincinnati, O.; WWJ, Detroit, Mich.; WHAS, Louisville, Ky.; WNAC, Boston, Mass. and a number of stations in New York and nearby cities.

A diagram of Todd's circuit is shown in Figure 1.

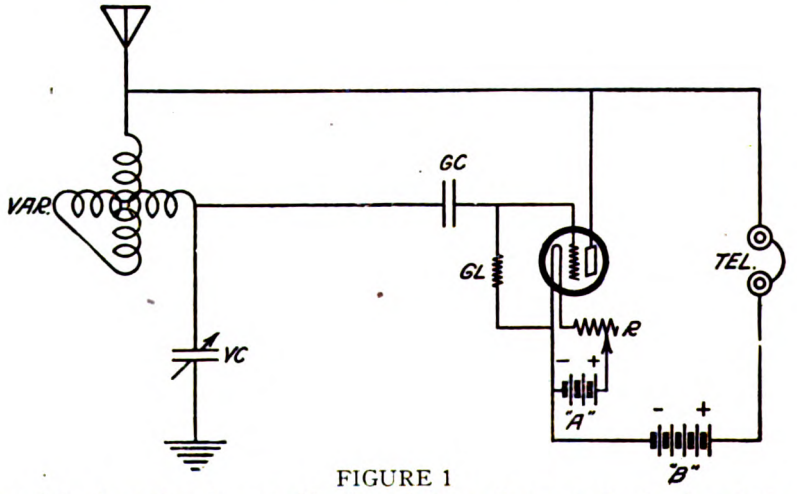

FIGURE 1

A novel hook-up that is a combination of the ordinary single circuit and the old ultra-audion circuit. The two tuning instruments are a variometer and a variable condenser. It has given exceptionally good DX results.

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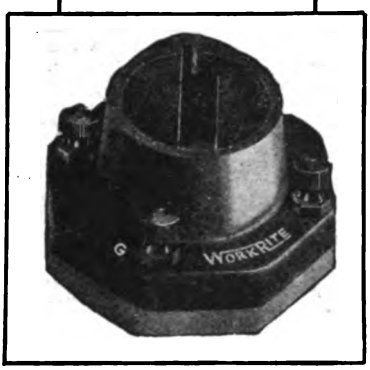
WORKRITE RESISTANCE CARTRIDGE

No need to buy a new Rheostat to get the 30 ohms required for the UV199 Tubes or the 15 ohms required for the 201A and 301A Tubes. Just put a WorkRite Resistance Cartridge on the circuit with your old 5 or 6 ohm Rheostat. Price 15 or 25 ohm **40c.**



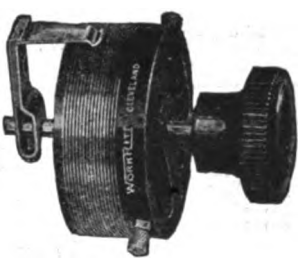
WORKRITE NON-MICROPHONIC SOCKET

Here is the right socket for your UV199 Tube. It is moulded with a sponge rubber base in one piece which is even better than the soft rubber recommended for use with this tube. Don't look any further. Get one right away. Price **60c.**

WORKRITE VERNIER RHEOSTAT $1.00

This instrument is the last word in Rheostats. 50,000 adjustments for $1.00. The drum is moulded and cannot shrink. No danger of the wires loosening. Pushing the knob way in turns off the filament. Turning the knob gives the finest adjustment. Often a turn of 1/32 inch will clear up a station or separate two stations. The WorkRite Super Vernier Rheostat is made with three different resistances so that there is a WorkRite Rheostat that will work with any Tube now on the market.

WorkRite Vernier Rheostat 6 ohms..... **$1.00**
WorkRite Vernier Rheostat 15 ohms..... **1.10**
WorkRite Vernier Rheostat 30 ohms..... **1.25**



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M812—43 plate .001 Mfd. $1.73
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These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with any inferior cheap condensers offered. We guarantee them to please you or your money back.

COMBINATION VERNIER VARIABLE CONDENSERS

M824—23 plate .0005 Mfd. Price $2.89
M826—43 plate .001 Mfd. Price 3.45

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning. High-grade design and construction. Finely finished. Suitable for panel mounting.

INDUCTANCE "HONEY COMB" COILS

Carefully made — fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Meters	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	M301	$0.39	M320	$0.89
35	175- 450	M302	.42	M322	.96
50	240- 720	M303	.49	M323	1.04
75	300- 910	M304	.54	M324	1.08
100	500- 1450	M305	.58	M325	1.13
150	600- 2000	M306	.63	M326	1.17
200	900- 2500	M307	.72	M327	1.26
250	1200- 3500	M308	.78	M328	1.35
300	1500- 4500	M309	.82	M329	1.36
400	2000- 5000	M310	.97	M330	1.57
500	2800- 6100	M311	1.12	M331	1.63
600	4000-10000	M312	1.27	M332	1.78
750	5000-12000	M313	1.43	M333	1.93
1000	7900-15000	M314	1.70	M334	2.28
1250	9750-19500	M315	1.92	M335	2.49
1500	14500-26500	M316	2.18	M336	2.65

COIL MOUNTINGS

M340—Three coil mounting $3.95
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High grade fine looking mounting. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. M732—Each 59c

This Guarantee Protects You. Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

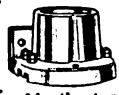
VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.
M105—Detector UV200 or C300 ..... $4.38
M112—Amplifier UV201A or C301A. Each $5.95
M115—5 Watt Transmitter 7.70
M107—WD11 1¼ volt 5.95
M109—WD11 adapter. Each 48c

VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs.
M140—For Standard Base Tubes. Each 39c
M108—For WD11 Tubes. Each 49c

PORCELAIN BASE AND TUBE



M144—Crosley for either panel or table mounting for Standard Base .. 36c

High Grade combination type for panel or table mounting Metal tube. Highly insulated base. For Standard Base Tubes.
M146—Each 45c

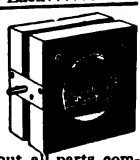
GRID CONDENSER

M162—Mounting holes spaced to fit lugs of above leak Cap. .00025 MFD. 14c
M163—Same as 162 but higher grade. Enclosed in metal case 39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
M100—Each 19c

VARIOMETER



M410—Completely assembled, price $2.69
Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings, positive contacts. Highest efficiency.
M411—Not assembled but all parts complete, except wire, including winding form $1.48

VARIO-COUPLER

With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.
M415—Price, completely assembled .. $2.45
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M417—Rotor ball only. Each 29c
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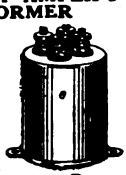


M995—Each $3.95

This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling, due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.
M234—10 to 1 Mounted. Each .. $3.48
M235—10 to 1 Unmounted. Each .. 2.95
M236—3 to 1 Mounted. Each 3.40
M237—3 to 1 Unmounted. Each. 2.85

FILAMENT CONTROL RHEOSTATS

Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
M130—Each 45c

Best grade. High heat resisting base. Diam. 2¼ in. cap. 1½ amp. Resistance 6 ohms. 1¼ in. Knob with pointer.
M132—Each 45c

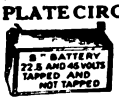
POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
M133—Each 98c

VERNIER RHEOSTAT

Gives exceedingly fine control of a battery current. A necessity for best receiving results.
M135—Each 78c

PLATE CIRCUIT "B" BATTERIES



You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.
M180—Signal Corps type, small size, 15 cells. 22½ volts. Each 95c
M184—Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each $1.80
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M736 Galena, Arlington tested, per piece 19c
M738 Silicon, Arlington tested, per piece 19c
M735 Tested, Galena, per piece 9c
M737 Tested, Silicon, per piece 9c

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

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FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

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Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
M240—100 ft. coil 49c
M242—500 ft. coil $2.35

Solid Bare Copper Wire, size 12
M244—100 ft. coil 67c
M245—500 ft. coil $3.05

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

M248—100 ft. coil 72c
M249—500 ft. coil $3.20

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M260 M262 M264-6

M260—Size 1x3¼. Two for..... 17c
M262—Size2⅛x3¼ Two for..... 55c
M264—Size 1½x4. Two for..... 69c
M266—Size 1½x 10½. Two for $1.29

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M980—Price.....$1.58
Protect your instruments with this lightning arrester. You cannot afford not to. Weather-proof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES

Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

M385 Single Pole Single Throw. Each 20c
M383 Single Pole Double Throw. Each 32c
M384 Double Pole Double Throw. Each 50c

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Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

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M381—1¼" Radius } Each
M382—1½" Radius } 19c

SWITCH LEVER STOP

Brass, polished nickel finish.
M386—Dozen 18c. Hundred $1.05.

ONE-PIECE DIAL AND KNOB

Moulded of highly polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

M900—2¼" Diam. for 3-16" shaft. Ea.19c
M901—2¼" Diam. for ¼" shaft. Ea..19c
M904—3" Diam. for 3-16" shaft. Ea...25c
M905—3" Diam. for ¼" shaft. Ea...25c
M906—3½" Diam. for 3-16" shaft. Ea.35c
M907—3½" Diam. for ¼" shaft. Ea..35c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

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Finest grade jacks, improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks only
M390—Open circuit. Each..43c
M391—Closed circuit. Each.49c
M392—Two circuit. Each..60c
M393—Single-cir. fila. control.69c
M394—Two cir. fila. control..85c

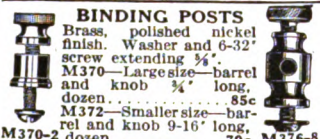
M395—Plug. Large space with set screws for attaching cord. Each.....49c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard jacks and Plugs. Solder connections. Nickel finished metal parts.

M387—Open Circuit Jack. Each..27c
M388—Two Circuit Jack. Each....35c
M389—Standard Plug. Each.....35c

BINDING POSTS



M370-2

Brass, polished nickel finish. Washer and 6-32" screw extending ⅜". M376-8

M370—Large size—barrel and knob ¾" long, dozen.....85c
M372—Smaller size—barrel and knob 9-16" long, dozen.....70c
M374—Large size with composition knob dozen.....50c
M376—Large size with hole for phone tip or wire, dozen.....80c
M378—Small size with hole for phone tip or wire, dozen.....35c

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A very high grade battery made especially for radio Service. Guaranteed. Properly cared for will give years of service for filament lighting.

M194-6v., 40 amp. size. Each..$10.00
M196—6-v.,80 amp. size. Each. 12.50
Price does not include transportation.

CABINETS

Fine-looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside High	Dimensions Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	M420	$2.48
6x10½"	5½"	10"	7"	M422	2.75
6x14"	5½"	13½"	7"	M424	3.30
7x14"	6½"	13½"	7"	M423	3.60
7x18"	6½"	17½"	7"	M426	3.90
7x21"	6½"	20½"	7"	M425	4.20
9x14"	8½"	13½"	10"	M428	3.70
12x14"	11½"	13½"	10"	M430	4.40
12x21"	11½"	20½"	10"	M432	5.25

SOLID GENUINE CONDENSITE CELERON PANELS

Notice our very low prices in this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished. Black finish which can be sanded and oiled for extra fine work.

Panel ⅛" thick 3-16" thick ¼" thick

Size Inches	Art. No.	Price	Art. No.	Price	Art. No.	Price
6x 7	M450	$0.50	M460	$0.75	M470	$0.98
6x10½	M451	.75	M461	1.18	M471	1.47
6x14	M452	1.05	M462	1.55	M472	2.05
7x14	M458	1.20	M468	2.60	M478	2.40
7x18	M453	1.55	M463	2.30	M473	3.10
7x21	M457	1.78	M467	2.65	M477	3.60
9x14	M454	1.60	M464	2.30	M474	3.10
12x14	M455	2.10	M465	3.10	M475	4.15
12x21	M456	3.15	M466	4.65	M476	6.20

HOME CHARGER BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips. Prices are Transportation Paid.

M201—For 6 volt battery.....$13.95

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These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

M770—2000 ohm.....$3.75

OTHER STANDARD BRAND HEADSETS

M751—Murdock 56, 2000 ohm.....$4.20
M752—Murdock 56, 3000 ohm.....4.95
M764—Frost, 2000 ohm.....4.20
M766—Frost, 3000 ohm.....4.85
M756—Red Head, 3000 ohm.....5.78
M758—Western Electric, 2200 ohm.$9.50
M754—Baldwin Type C with universal jack plug.....11.75
M755—Baldwin Type C unit.....5.50
M768—Brandes, 2000 ohm.....6.90

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

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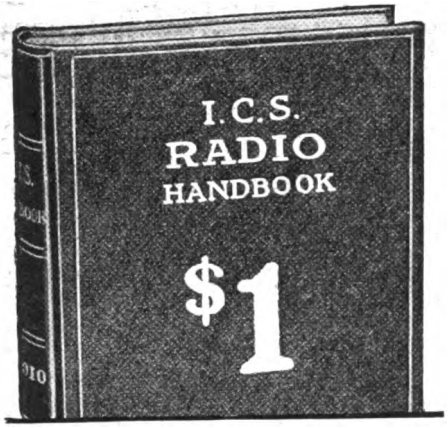

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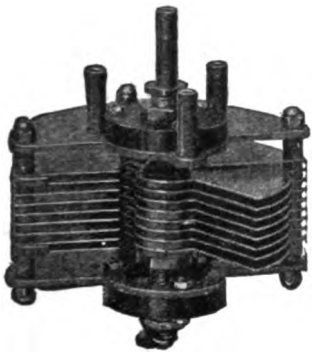

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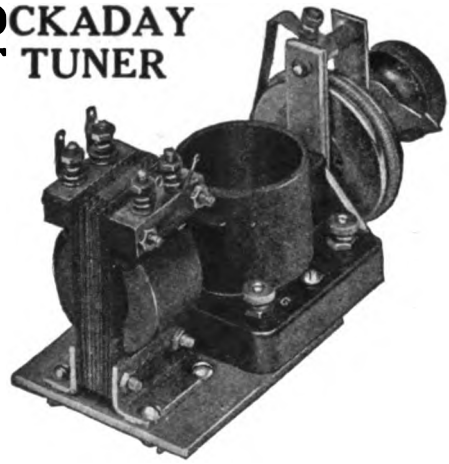

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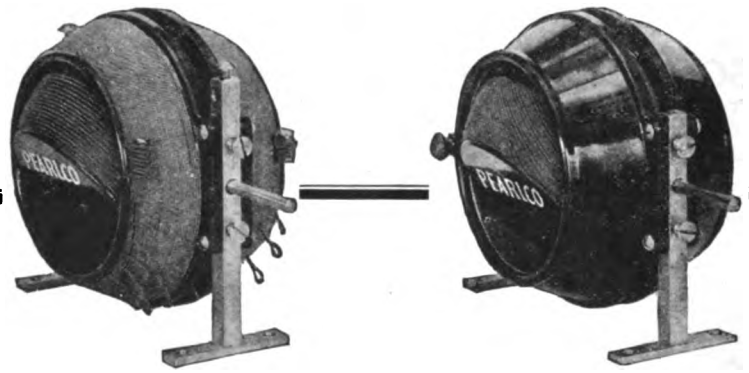

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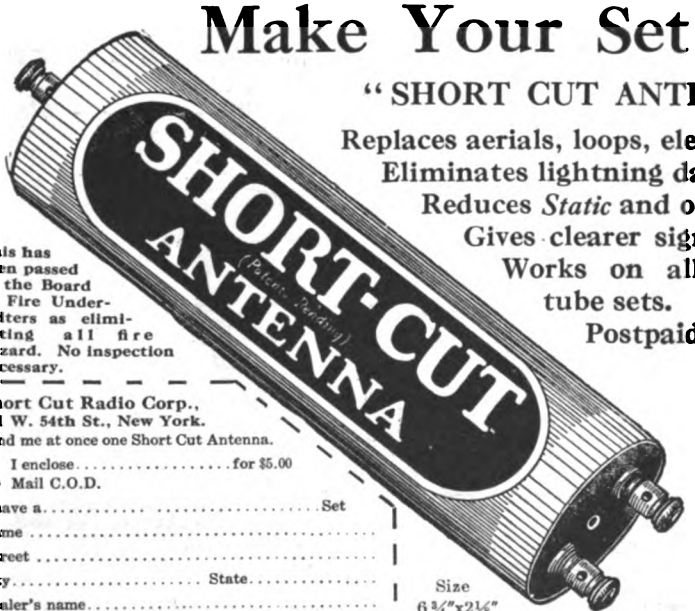

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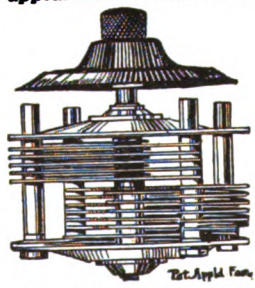

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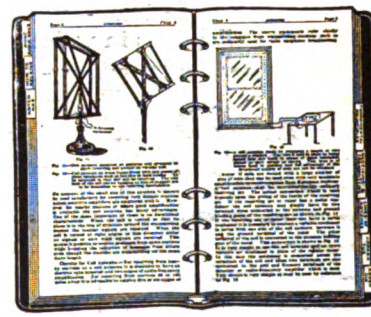

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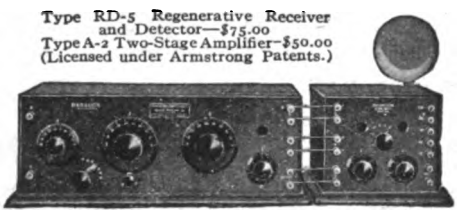

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Compare it with others—even those selling at double the price—and the ***Victophone*** will be your choice.

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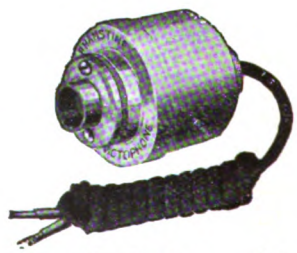

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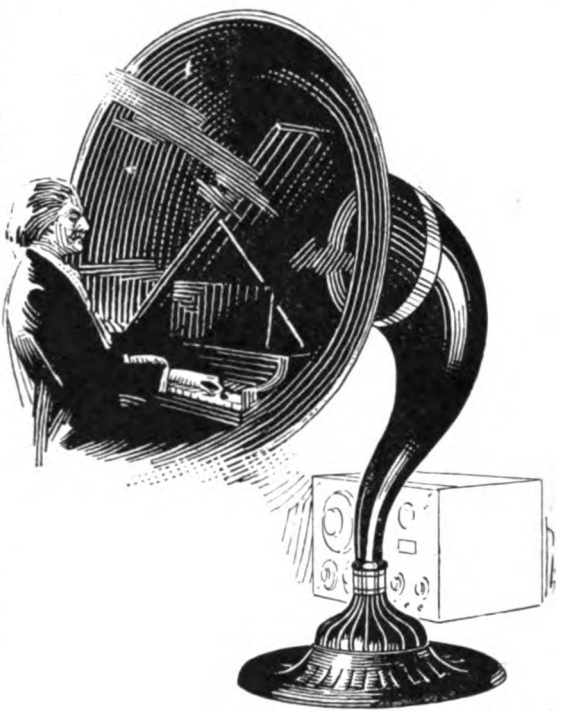

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14-inch Horn for the Home **$30**
21-inch Horn for Concerts **$35**

JOBBERS DEALERS ***Write for description of Geraco Line, and prices***

GENERAL RADIO CORPORATION
Makers and Distributors of High-Grade Radio Apparatus

CHICAGO — PHILADELPHIA, *S. W. Cor. 10th and Cherry Streets* — PITTSBURGH

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THE BEST HEADSET

HIGHEST AUDIBILITY
PERFECT MATCHING
GREATEST VOLUME

Why Strain Your Ears?

T. B. H. Headsets reproduce clearly and naturally. No "Fuzz" or "Tinny" tone. Extremely sensitive.

Aluminum cases—6 Foot cord—Weight 12 oz.
Type 6-A 17500 Turns (2200 ohms) Hard Rubber caps $7.00
Junior 16000 Turns (2000 ohms) Composition caps $5.00

If your dealer does not carry them he will order them for you
Dealers and Jobbers write for discounts

THE T. B. H. CORPORATION

DANSVILLE, NEW YORK, U. S. A.

DISTRIBUTORS

The Eastern Specialty Co., Philadelphia, Pa. (Metropolitan District and South Atlantic States)
Donaldson Radio & Service Station, Kansas City, Mo. (Southwestern States)
Marie A. Alvarez, Havana, Cuba (Cuba)

ATWATER KENT

RECEIVING SETS AND PARTS

Detector 2-stage Amplifier

ATWATER KENT Sets and Parts are ideal for summer use due to their compact and rugged construction and the fact that they are moisture-proof. They are made mostly of condensite and are thoroughly water-proofed.

Send for an illustrated folder showing all parts and complete sets.

ATWATER KENT MFG. COMPANY
4933 Stenton Ave., Philadelphia

1200 MILES
with a Crystal Set Using

A Needles, California, radio fan writes:
"Using M. P. M. Crystal, I picked up Los Angeles, San Francisco, Salt Lake, Denver and St. Louis. It is far superior to any crystal I have ever used."

Before discarding your Crystal Set for an expensive Tube outfit, give M. P. M. Crystal a trial!

¶ ***Beware of imitations!*** The genuine Million Point Mineral is sold only in separate crystals packed by our company in boxes bearing the trade-mark "M. P. M."

Send 25c and name of your Radio Dealer for a sample M. P. M. Crystal—concert-tested and guaranteed. 35c for mounted Crystal.

M. P. M. SALES COMPANY

Department PR

247 So. Central Ave. Los Angeles, Cal.

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MU-RAD RECEIVERS
SUPREME

The reception of far distant stations, heralded by owners of ordinary sets as a rare achievement, is the common experience of those who own MU-RAD Receivers. Only a 2-foot loop aerial required. Sensitivity finer than anything you have ever known. Faithful reproduction. Selects with amazing ease and sharpness. Yet these highly perfected sets are very simply operated. Guaranteed to receive 1000 miles, minimum. The maximum record is broken every week. **Send for literature.**

The New Star in the Radio World

MU-RAD LABORATORIES, INC.

809 FIFTH AVE. ASBURY PARK, NEW JERSEY

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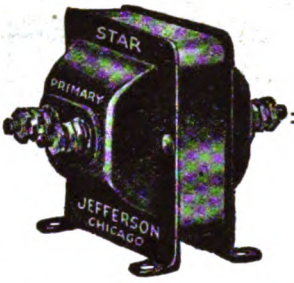


JEFFERSON

Amplifying Transformers

have gained an enviable reputation for audibility and amplifying power. In tens of thousands of receiving sets they are insuring 100% amplification—increased range, super-sensitivity, and the elimination of howling and distortion.

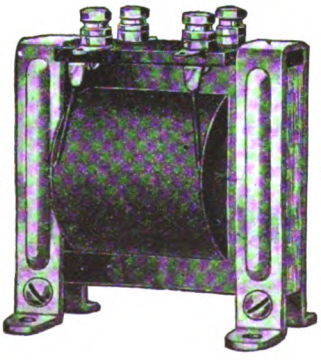
This positive preference rests on the unmistakable superiorities of design and operation which make Jefferson Amplifiers the choice of discriminating radioists.

FIVE JEFFERSON TYPES

The five Jefferson types meet the demand for an audio-frequency transformer for every requirement. In this assortment you are sure to find the transformer which will make your set super-sensitive, and enable you to tune in distant stations with ease, and freedom from distortion.

Radio Bulletin Sent Free

Jefferson Electric Mfg. Co.
427 S. Green Street Chicago



AMSCO means

Radio Insurance

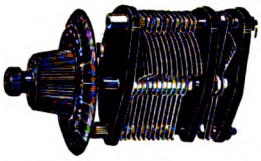
Protection assured!

Every element of risk is eliminated by our money-back guarantee, when you buy Amsco Products. Every thing we make—from the wonderful Melco-Supreme Radio-Frequency Receiver (150-750 meter wave length) to the smallest binding post, is scientifically correct, mechanically perfect and built for life-long durability.

PART OF THE AMSCO LINE

Compensating Condenser

Rheostat (6, 20 or 50 Ohms)

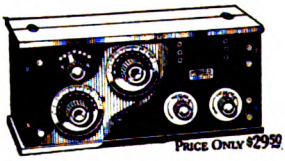


Vernier Air Condenser

AMSCO CONDENSERS are especially adapted for use with the Cockaday Four-Circuit Tuner.

Write for booklets illustrating and describing our entire line of quality apparatus.

AMSCO PRODUCTS, Inc.
Successors to Mortimer Radio Corp. and Advance Metal Stamping Co.
FAIRBANKS BUILDING
Broome & Lafayette Sts., New York City



MIRACO GETS 'EM 1500 MILES AWAY

At this low price you get the efficiency of a $50 set. It is a two tube radio frequency receiver—picks up stations 1500 miles away under good conditions—everywhere—any time. This outfit can be operated with a **dry cell** or storage battery. Cabinet is of solid mahogany and workmanship the finest throughout. Order direct or send for catalogue.

DEALERS—write for proposition—it's a winner.
AGENTS—wanted everywhere—write for territory QUICKLY

THE MIDWEST RADIO COMPANY
812 Main Street Cincinnati, Ohio

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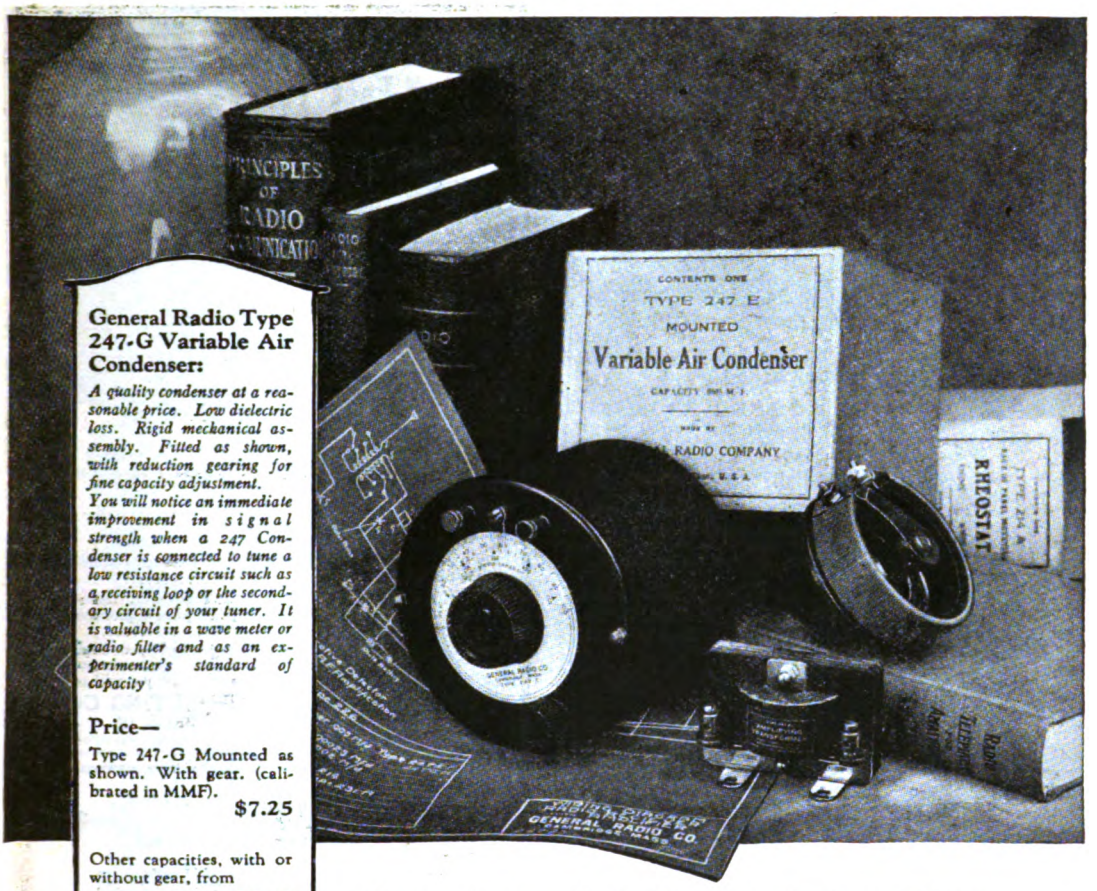

General Radio Type 247-G Variable Air Condenser:

A quality condenser at a reasonable price. Low dielectric loss. Rigid mechanical assembly. Fitted as shown, with reduction gearing for fine capacity adjustment. You will notice an immediate improvement in signal strength when a 247 Condenser is connected to tune a low resistance circuit such as a receiving loop or the secondary circuit of your tuner. It is valuable in a wave meter or radio filter and as an experimenter's standard of capacity

Price—

Type 247-G Mounted as shown. With gear. (calibrated in MMF).

$7.25

Other capacities, with or without gear, from

$3.25 to $6.00

Type 231-A Transformer

Gives the maximum amplification possible without distortion. Like all apparatus manufactured by The General Radio Company, the Type 231-A is guaranteed.

Price - - - $5.00

Type 214 Rheostat

A quality rheostat for the new UV201-A and 199 Tubes. A convenient, practical instrument, equally well adapted for experimental service or permanent installations. You'll never cause unpleasant noises in the phones when you rotate the contact arm of a Type 214 Rheostat.

Prices—

For UV201-A and UV199 Tubes, 20 Ohms. For Tubes such as UV201, 7 Ohms—

$2.25

If you value your Radio Equipment by the satisfaction it gives rather than by its initial cost, you're a potential customer of General Radio Company.

For more than eight years, in the design and manufacture of Radio and Laboratory Apparatus, we've set a standard of quality rather than of price. The results have justified the policy.

Today, men who know and use Radio Equipment of the better sort—whether Amateurs, Engineers or Scientists—accept the General Radio Company's name on an instrument as a guarantee of satisfaction.

If you're looking for Radio Apparatus—Variable Condensers, Amplifiers, Rheostats, Potentiometers, Sockets, Hot Wire Ammeters, Audibility Meters, Decade and Capacity Bridges, Etc., buy General Radio Company's instruments—apparatus that offers a little greater value per dollar, gives a little more satisfaction, and is designed and made a little better.

Our Bulletin 914U not only describes our Amateur line, but is an educational pamphlet of value. Sent free on request.

GENERAL RADIO CO.

Manufacturers of
Radio and Electrical Laboratory Apparatus
Massachusetts Avenue and Windsor Street
Cambridge, Mass.

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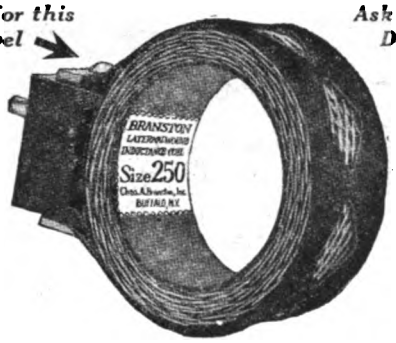
Look for this Label *Ask your Dealer*



Improve Your Present Set or Make a New One Better by Using

BRANSTON Lateral Wound Honeycomb Inductance Coils

(Licensed under Deforest Patents)

Ask your "Old Timer" Radio friend why sets using Honeycomb Coils are Best.

Send 4c in stamps for Series 1 "Hook-Up" Circular showing five good Honeycomb coil hook-ups and Catalog of famous Branston Radio materials. Write today. Give us name of your Radio Dealer. If he can't supply you, let us know.

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Toronto, Ont.

BRANSTON RADIO

A Plain Statement of Fact

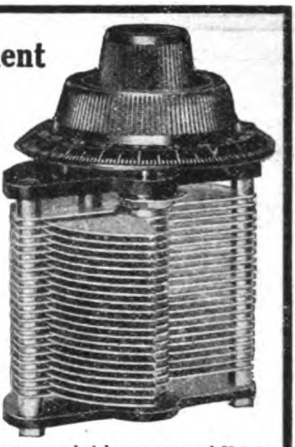
When you say a circle is round or a man is "square" or a job is done you've told the *whole story.*

When we say that

"UNITED" Radio Condensers and Transformers

Give Complete Satisfaction

we leave nothing more to be said. They *satisfy* because both design and construction are *right.*



United Variable Condensers have a wonderful new patented **Vernier Dial Control,** which makes possible twice as fine adjustment as any Vernier on the market.

43 plate	$6.50	5 plate	$5.00
23 plate	6.00	3 plate	4.75
11 plate	5.50	Postpaid	

Vernier alone can be attached to any plate condenser by drilling one hole $2.50

"United" Amplifying Transformer Audio Frequency. Instrument is magnetically shielded, a very fine piece of precision workmanship $4.50

Show this ad to your Dealer and ask him to supply your needs at the above prices. If he cannot do so remit to us direct, under our money-back guarantee and give us name and address of Dealer you wish to favor.

UNITED MFG. & DISTRIBUTING CO.
536 Lake Shore Drive, Chicago, Ill.
NEW YORK OFFICE: 50 Church St., New York City, N.Y.
SAN FRANCISCO OFFICE: 709 Mission St., San Francisco, Cal.

Warren Radio Loop, cut away to show construction

For Camping and Vacation Use

WARREN RADIO LOOP

WITH a Warren Radio Loop you can easily take your present set with you to camp, shore or mountain, or you can build a very compact portable set. The Warren Loop fits inside a small cabinet and combines aerial and tuning device. All enclosed so that damp, dirt and rough usage cannot harm it. Various types according to your requirements. Write for Bulletin I 102.

A TYPE FOR EVERY SET AT THE BEST DEALERS

Type A-737 (300-700 meters) 6 inches square—non-directional.....$10
Type A-7236 (175-1000 meters) 6 inches square—non-directional.....$12
Type B-2837 (300-700 meters) 18 inches square—directional.....$20
Type BL-28120 (200-18,000 meters) with honeycomb coil. 18 inches square—directional.....$25

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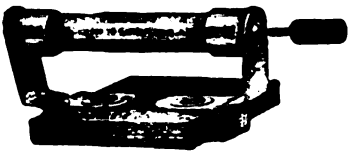
V-DE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.

New Combination DURHAM DUBILIER



Get more of the distant stations

Every DX fan knows it all depends upon a quiet tube and sharp tuning. With the DURHAM plunger at your fingertips, the mushy blur changes to a clear, pure tone—DX at its best. DURHAM Variables provide accurate adjustment for every make of tube. Use them with the famous DUBILIER Grid Condensers. Then satisfaction is doubly assured.

DURHAM Variables		**DUBILIER Micadons**
No. 101 to 5 megs.	+	.00025 mfd.
No. 201A to 10 megs.		.00050 mfd.

There's a combination for your tubes.

DURHAM & CO. 1936 MARKET ST. PHILADELPHIA

Dealers and Jobbers: Read the articles in this issue on Radio vacations and build your stock to suit.

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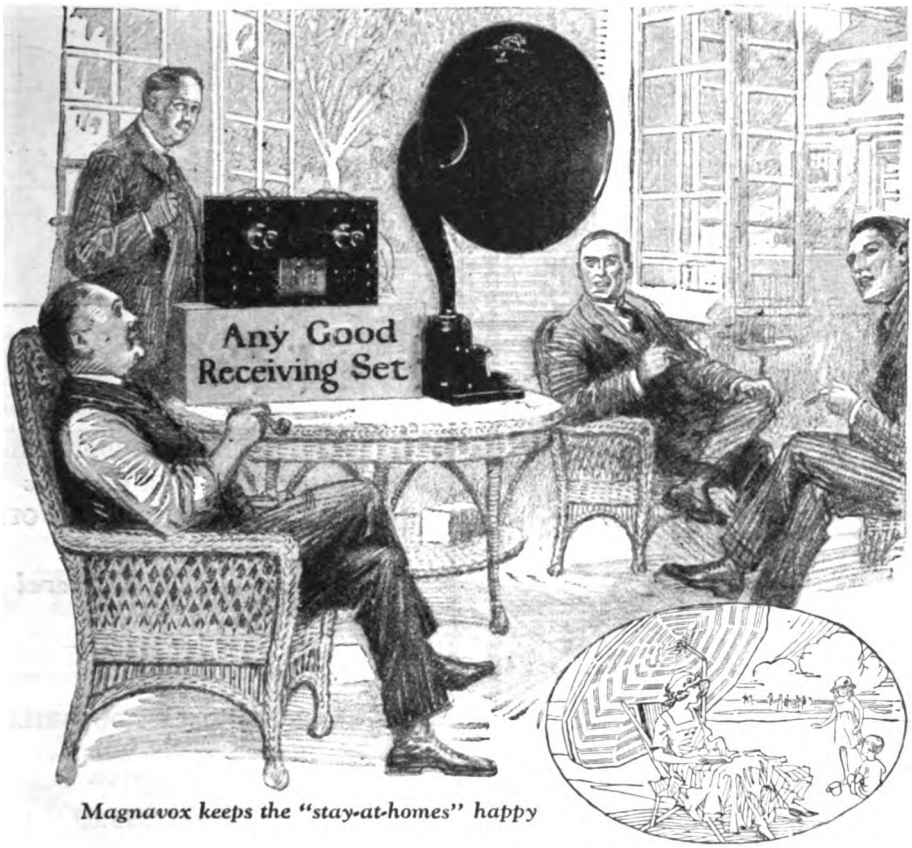

Magnavox keeps the "stay-at-homes" happy

THE "boys" just naturally make their headquarters in proximity to the receiving set whose owner has been wise enough to add a Magnavox Reproducer and Power Amplifier. When "Magnavox invites you," the Radio party is sure to be a *success.*

Magnavox R2 Reproducer and 2 stage Power Amplifier (as illustrated) **$115.00**

R2 Magnavox Reproducer with 18-inch horn: the utmost in amplifying power; requires only .6 of an ampere for the field **$60.00**

R3 Magnavox Reproducer with 14-inch curvex horn: ideal for homes, offices, etc. **$35.00**

Model C Magnavox Power Amplifier insures getting the largest possible power input for your Magnavox Reproducer
2 stage **$55.00**
3 stage **75.00**

Magnavox Products can be had from good dealers everywhere. Write for new booklet.

THE MAGNAVOX COMPANY
Oakland, California
New York Office: 370 Seventh Avenue

MAGNAVOX PRODUCTS

No Radio Receiving Set is complete without them

7-R

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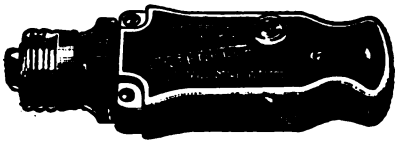
Summer Static Overcome

"Good-bye Aerial"



ANTENELLA

No aerial or antenna needed

All outside wiring, aerial, lightning arresters, switches and other inconveniences so inductive to static are eliminated.

Merely plug **Antenella** in any light socket and you can enjoy all Radio pleasures in any room in your home, apartment or hotel. No current consumed.

New Improved

ANTENELLA

NOW ONLY $1.25

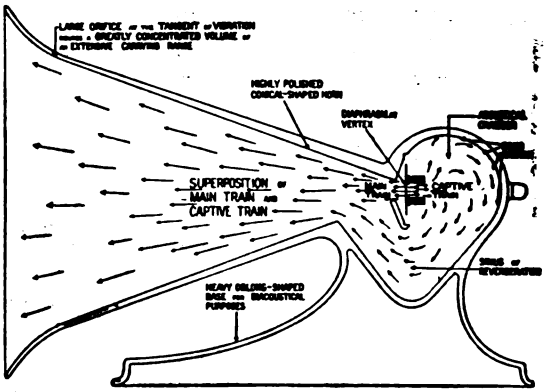
formerly $2.00

At your dealers—otherwise send purchase price and you will be supplied postpaid.

Chas. Freshman Co. Inc.

Radio Condenser Products

106 SEVENTH AVENUE, NEW YORK


HIGHLY POLISHED CONICAL-SHAPED HORN
SUPERPOSITION OF MAIN TRAIN AND CAPTIVE TRAIN
CAPTIVE
HEAVY OBLONG-SHAPED BASE FOR ACOUSTICAL PURPOSES

ECHO-TONE

GIVES FIBRE NEEDLE TONE TO THE RADIO PHONE

A REAL PORTABLE LOUDSPEAKER

Unaffected by Climatic Conditions

NO PART TO BREAK OR JAR OFF

IDEAL FOR

Vacation, Outing or Travel

NO PULP to Crumble
NO WOOD to Warp
NO TIN to Bend

But

CASTED ALUMINUM for DURABILITY

Now Equipped With A TONE REGULATOR

Retail Price $35.00

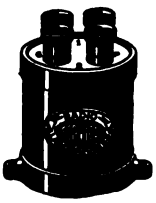
WILLIAMS RADIO COMPANY

Radio Tone Specialists

1438 Washington Blvd., Detroit, Mich.

RT-A2

The Audio Frequency Transformer that gives you perfect Tone Quality and High Amplification without distortion. Moisture-proof—it is ideal for the seashore. Letters received every day state that RT-A2 passes every test and fulfills the most critical requirements of experts and amateurs.



Use RT-A2 transformers at once and enjoy better radio reception.

Price $6.50 at all good dealers

RASLA SALES CORPORATION

National Distributors

Dept. P, 10 East 43d St., New York City

FREE Radio Catalog

Our big stocks of standard makes of radio sets, parts and supplies enables us to make prompt shipment from stock. Play safe—buy standard equipment from a reliable house. No cut price material.

Send $1.25 for Univernier for close tuning—mention size of Condenser or Variometer shaft; $2.00 for 6-phone plug.

JULIUS ANDRAE & SONS CO.

In Business since 1860

127 Michigan Street Milwaukee, Wis.

Rathbun Variable Condensers

have 4 points of superiority over all others.

(1) Only 1 hole to drill for mounting.
(2) Plates die-cast in milled brass tubes.
(3) Formica ends for plate protection.
(4) End and side play eliminated through special die-cast Babbitt bearings.

Vernier, 11 plate, 23 plate and 43 plate at your dealers or direct from

Rathbun Mfg. Co., Jamestown, N. Y.

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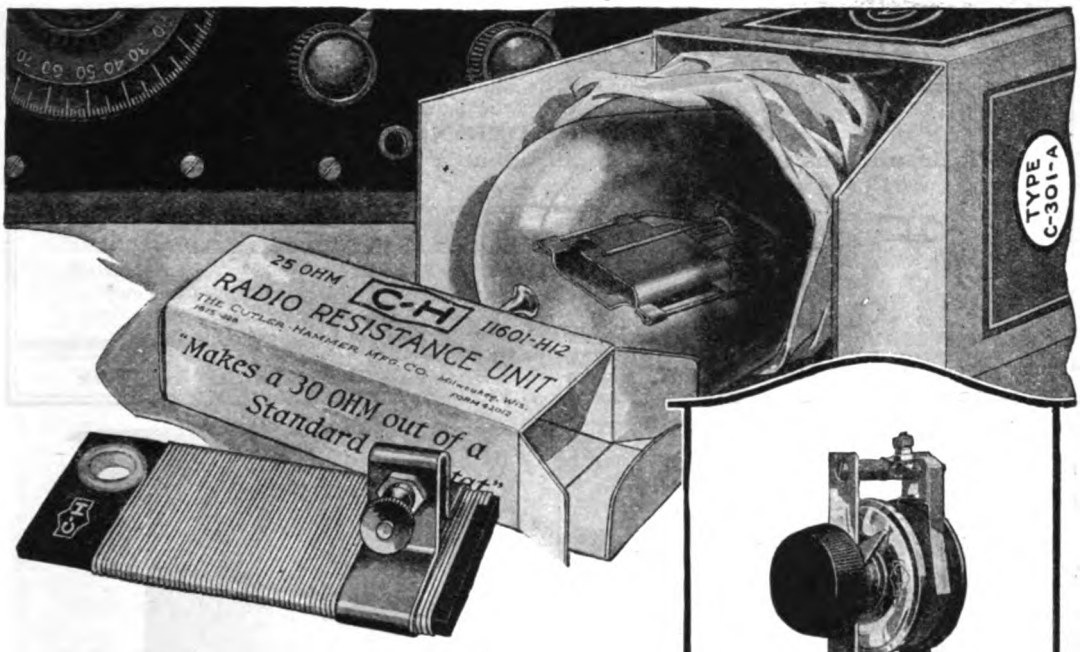


Buy This Unit With Your New Tube!

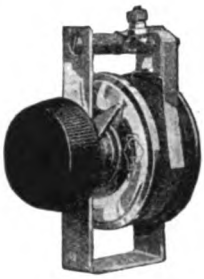
It Saves the Cost of New Rheostats and the Trouble of Redrilling Your Panel

You can put the new "A" Type (C-301-A or UV201-A) receiving tubes in your set and enjoy better results *tonight*. The C-H Radio Resistance Unit adds to your *present* rheostats just the number of ohms required for the regulation of these new ¼-ampere tubes. You do not have to spend several dollars for new rheostats—nor miss a single hour's entertainment while you bother to redrill your panel for them. Just put the eyelet of the C-H Unit over the post of your rheostat, and attach the wire you had to remove to do so to the binding post of the unit. Regulation is obtained from the front of the panel as before—but the unit itself is adjustable to care for changes in battery potential.

Panel Mounting if Desired

The C-H Radio Resistance Unit may be mounted directly on the panel, if desired, attached to a single binding post and wired in series with the rheostat. Its compact, handy size and many possible ways of mounting make it adaptable to every receiving set. Price 25c at all radio dealers and supply houses.

THE CUTLER-HAMMER MFG. CO.
Member Radio Section, Associated Manufacturers of Electrical Supplies
MILWAUKEE · WISCONSIN



The C-H 30-Ohm Rheostat

The newest of the famous line of C-H Radio Rheostats. Built by the master builders of rheostatic control apparatus and engraved with their guarantee of satisfaction — a trademark you should demand on the vital instruments for your receiving panel.

Designed with a resistance of 30 ohms for the control of the new "A" type receiving tubes (C-301-A and UV201-A). Finished in dull satin nickel and ebony black. Arranged for panel mounting, pointer indicating, and furnished with genuine Thermoplax knob. The instrument your new receiving set deserves.

Type 11601-H9 . . . . . $1.50

One-half Million C-H Radio Rheostats Now in Use

CUTLER-HAMMER

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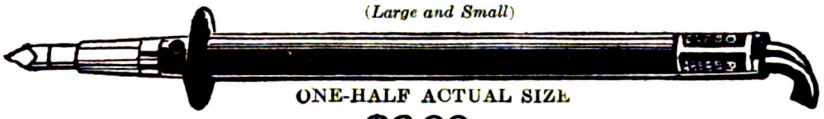
Both the manufacturers' and amateurs' problem on all fine work is readily solved by the instrument constructed for this particular purpose.

THE POST SOLDERING IRON

Platinum Heating Unit—Interchangeable Tips—Universal Current

(Large and Small)



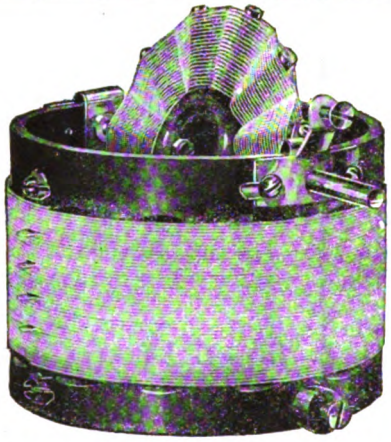
ONE-HALF ACTUAL SIZE

$6.00

Awarded Certificate of Excellency, N. Y. Evening Mail Radio Institute

From your Dealer, or write

POST ELECTRIC COMPANY (Instruments Division), 30 E. 42nd St., New York



HARTMAN VARIOCOUPLER

WITH

SPIDER WEB ROTOR

PROVIDES

REMARKABLE SELECTIVITY IN TUNING

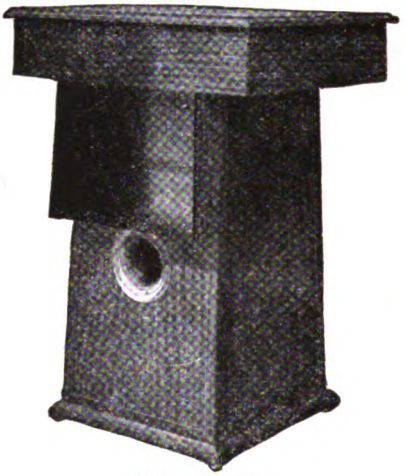
Designed for us by Alfred A. Crossley

Price $6.50

Write for bulletins on Hartman Radio Products

THE HARTMAN ELECTRICAL MFG. CO.

MANSFIELD, OHIO



Patent Pending

THE FAVORITE

A perfected radio cabinet, a powerful generator of radio waves. Eliminates static and danger from lightning. No loop, no aerial, no ground or other attachments necessary, has good range, provides for sharp selective tuning, operates any good hook-up with any good vacuum tube.

Carries and conceals all batteries and equipment and is a beautiful piece of household furniture.

Write for descriptive matter and prices.

Manufactured by

G. A. BARTHOLOMEW

409 Guardian Bldg. Cleveland, Ohio

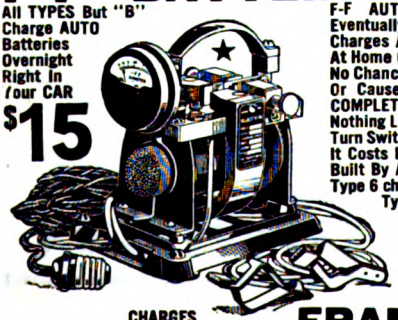
(Will lease shop rights)

F-F BATTERY CHARGER

CHARGES RADIO "A" & "B" & AUTO STORAGE BATTERIES at HOME Overnight, for a Few Cents From Any 100 to 130 Volt 60 Cycle A. C. Lamp Socket.

All TYPES But "B" Charge AUTO Batteries Overnight Right In Your CAR

$15



CHARGES RADIO & AUTO BATTERIES.

F-F AUTOMATIC MAGNETIC TAPER CHARGE DESIGN made BATTERY CHARGING POPULAR. Eventually You Will Buy An F-F CHARGER & The Sooner You Buy One; The More You Save. A-B Charges All 6 Volt & up to 120 Volts Of "B" & Loud Speaker Storage Batteries In Series Inductively At Home Overnight. Disconnecting & Multiple Connections Unnecessary. Charging Circuits Separate. No Chance For Grounds, or Short Circuits. Nothing To Slop Over, Be Filled, Burn Out, Need Attention Or Cause Trouble. Infusible Rectifying Brushes Maintain Constant Efficiency Uninterruptedly. COMPLETE PORTABLE AUTOMATIC. No Skill Required. AMMETER eliminates Guess Work. Nothing Like It Made. Lasts A Lifetime. Screw Plug In Lamp Socket; Snap CLIPS on Battery Terminals; Turn Switch & Battery Is Charged In Morning. Charged Batteries Mean Fewer Expensive Replacements. It Costs Less To Buy An F-F CHARGER Than To Be Without One. INSIST on The F-F CHARGER. Built By A Master Of The Art In 7 TYPES. Thousands Sold Make Possible These POPULAR PRICES: Type 6 charges 6 Volt Battery At 6 amperes $15 Type 12 charges 12 Volt Battery At 5 amperes $15 TypeBchargesRadio"B"BatteriesUpto120Volts$15 Type A-B Is Combination Of 6 & B $20 Type166charges6VoltBatteryAt12amperes$20 Type1612charges12VoltAt7amps$20 Type1626 Is a Combination Of Types 166 & 1612 and Charges Both 6 & 12 Volt Batteries $28 Types B & A-B are RADIO Specials. Types 166, 1612 & 1626 are For Heavy & Rapid Charging. SHIPPING WEIGHTS Complete with AMMETER & BATTERY CLIPS 11 to 15 lbs. PURCHASE from DEALER; Mail Check, or WRITE us to Ship TYPE desired C. O. D. ORDER Now, or WRITE Immediately for FREE Descriptive CHARGER Bulletins 44 & 44A.

FRANCE MFG. CO., Cleveland, Ohio.

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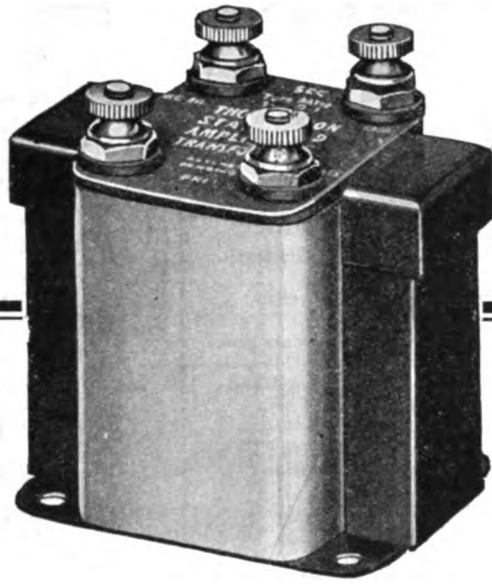
Price, Mounted Only

6 to 1 ratio transformer.....$4.50
(With Red Label)

3½ to 1 ratio transformer.....$4.00
(With Blue Label)



The New THORDARSON

Audio Frequency Amplifying Transformer

FOR the past twenty-eight years THORDARSON transformers have been installed in the country's greatest engineering concerns, manufacturing plants and immense central stations. The first 1,000,000 volt transformer in the world was devised and constructed by THORDARSON engineers. The history of the improvement of transformers could be read in the history of THORDARSON development.

The new shell type audio frequency transformer is scientifically and mechanically perfect. A thorough understanding of its construction will convince you that it would be physically impossible for the transformer you are now using to obtain results equal to the THORDARSON in either amplification or tonal perfection.

SPECIFICATIONS

THORDARSON transformers are constructed and assembled entirely in the THORDARSON plant—not merely assembled as is the case of most transformers now on the market. Core is made of .007 mil highest grade silicon steel, No. 36 gauge—the cross section of which measures ¾ inch—twice that of an ordinary amplifying transformer. The coils of No. 40 wire are ***square layer wound*** to fit the square core—wound by machines designed and developed entirely by THORDARSON. Our new coil is a recent achievement of THORDARSON engineers. Between each layer of wire is the finest grade 1,000 volt condenser paper—the transformer is guaranteed and tested to withstand 600 volts D. C. without breakdown.

These transformers are designed to serve with tubes now on the market. For a one stage set, use the 6 to 1; for two stages, hook up the 6 to 1 type on the first stage, and the 3½ to 1 on the second stage. These transformers which balance the resistance of the plate circuit of one tube with the grid circuit of the following tube has proven to produce the maximum of amplifying efficiency by exhaustive tests and experiments at all audible frequencies.

Your receiving set and the pleasure you derive from it depends upon the transformer you use and it is our firm belief that this new THORDARSON Amplifier is the finest the market affords. For sale at good dealers at our new prices.

THORDARSON

ELECTRIC MANUFACTURING COMPANY

500 HURON STREET, CHICAGO

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Radio Advantages of bakelite-dilecto!!

1

(A Laminated Phenolic Condensation Product)

(1) Highest Dielectric Strength.
(2) Resists Heat.
(3) Cannot Warp or Swell.
(4) Resists Water.
(5) Unharmed by Solvents and Milder Acids.
(6) Tough, Durable; Yet Readily Machined.
(AND MANY OTHERS)

2

3

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware

Dealer Service from:
New York, 233 Broadway
Pittsburgh, 301 Fifth Ave.
Chicago, 332 S. Michigan Ave.
San Francisco, 75 Fremont St.
Los Angeles, 411 S. Main St.
Seattle, 95 Connecticut St.

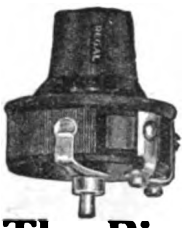
4

5

6

X X

Regal No. 140 Filament Rheostat



Has full exposed resistance wire, giving critical adjustment so necessary to the efficient operation of a vacuum tube. Fine, smooth working control. Handsome knob, heat resistance base and highly nickel-plated parts. 6 ohms resistance—2.2 amperes..... **$1.00**

30 Ohm Rheostat $1.25

The Big "Regal" Line

Power Rheostats, Potentiometers, Inductance Switch, Variocoupler, Tube Sockets, Jacks, Condensers, Knobs, Dials, etc. Send for Catalog No. 27.

(If your dealer does not handle Regal Products—write us direct)

"Regal" Inductance Switch

A 15-point switch complete in one unit. Requires but one hole to mount on panel. Smooth wiping contact overheads machined to same height on one piece contacts. Complete soldered assembly attached, or removed from panels by means of one threaded shaft bushing. Gives inductance regulation by dial contact **$2.00**

The American Specialty Co.

Bridgeport, Conn.

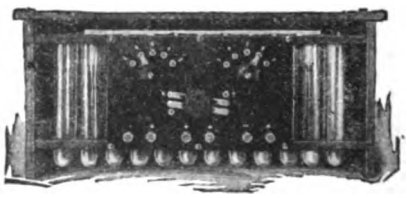
ACKERMAN 11 POINT INDUCTANCE SWITCH

(Actual Size)

With Dial ***$1.25***
Without Dial ***1.00***

Sent Prepaid upon Receipt of Cash or Money Order
Liberal Discounts to Jobbers and Dealers

ACKERMAN BROTHERS COMPANY, Inc.
Dept. "PR," 301 W. 4th Street, New York, N. Y.



KICO Storage "B" Batteries give long service at low cost

Alkaline type, will not sulphate or buckle. Not harmed by short-circuiting, overcharging, or standing idle. Panel switches afford single cell variations. Easily re-charged from any 110-volt A.C. line by means of small home rectifier. One charge lasts three to six months in detector plate circuit.

Prices without rectifier:	Plain	(With Panels)
16 cell 22 volt.....	$5.50	
24 cell 32 volt.....	$7.25	$11.75
36 cell 48 volt.....	$9.50	$14.00
50 cell 68 volt.....	$12.50	$17.00
78 cell 100 volt.....	$17.50	$22.50
108 cell 145 volt.....	$23.50	$28.50
Unmounted rectifier....	$1.00	
Mounted rectifier.....	$2.50	

SATISFACTION GUARANTEED

Money is refunded if user is not satisfied after 30-day trial. Write for full information on "A" and "B" Batteries.

KIMLEY ELECTRIC COMPANY, Inc.
2667 MAIN STREET BUFFALO, N. Y.

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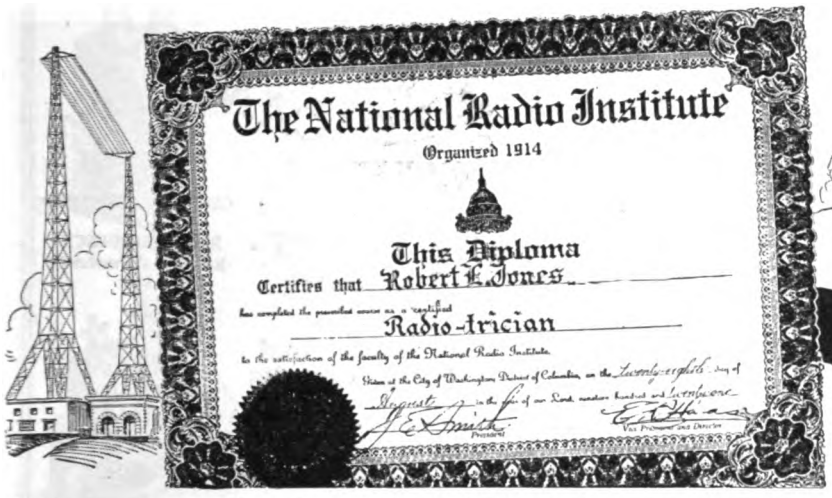

This Certificate Opens the Way to the Best Radio Positions

Get It—You Can Earn Big Money With It

No previous experience in electricity or Radio is necessary. In a few short months, you can easiiy win this certificate and qualify for one of the splendid, big money positions in Radio.

Edwin L. Powell is an Expert Radio Aide at the Washington Navy Yard and earns **Big Money.** Leo Goldblatt is earning a Big Salary and all expenses paid as a radio operator. James F. Nicholls is earning $150 a month and all expenses as a radio instructor at Walter Reed Government Hospital. Harry Ruck has made **big money** manufacturing radio sets. Hundreds of other men are occupying equally attractive positions after winning our Certified Radio-trician certificate.

Read in the panel of the fine salaries paid in all the wonderful radio positions for which you can qualify once you have this certificate.

Pick Out the Job You Want And We Will Help You Get It

This is a brief list of the positions in the Radio field today, and the salaries paid.

Radio Mechanic, $1,500 to $4,000 a year.
Radio Inspector, $1,800 to $4,500 a year.
Radio Auditor, $1,200 to $1,800 a year.
Radio Salesman, $2,000 to $10,000 a year.
Radio Engineer, $3,500 a year and up.
Radio Executive, up to $15,000 a year.
Radio Aide, $6 to $10 a day.
Radio Draftsman, $7 to $15 a day.
First Class Ship Operator, $105 a month, all expenses paid.
Second Class Ship Operator, $95 a month, all expenses paid.
Third Class Operator, $85 a month, all expenses paid.
Commercial Land Station Operator, $150 a month and up.
Broadcasting Station Operator, $125 to $250 a month.

Easy Now to Become A Certified Radio-trician

No other work in the world today offers such opportunities, such big money, such rapid advancement, such a promising future as does Radio. And the Expert Radio-trician is the man who is in a position to choose the best of these opportunities—to jump farthest ahead in this newest and fastest growing industry.

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An extraordinary feature of this course is the use of four patented instruments, owned exclusively by us, which give practical training in radio operation, installation, maintenance and repair—all of which you **must** have to become an Expert Radio-trician.

Among these instruments is the wonderful Natrometer, said by experts to be the perfect device for teaching the Radio Code. All of these instruments are loaned to students.

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Thousands of positions are open to Certified Radio-tricians. Find out what **your** opportunities are in this fascinating profession. Send for interesting book, "Your Opportunity in Radio," which gives complete details on plan by which the National Radio Institute quickly qualifies you at home in spare time as a Certified Radio-trician. Send the coupon or a postcard for free book NOW. **NATIONAL RADIO INSTITUTE, Dept. 32-G, Washington, D. C.**

Radio Operator

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Radio Salesman

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Send me your book, "Your Opportunity in Radio," with full particulars about the opportunities in radio, and how you will quickly train me in my spare time at home to win a Certified Radio-trician Certificate. Also about your employment service.

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$.62 A two cell 1½ volt dry battery

Lead Your ACE

A Better Battery Makes All the Difference In the World

NO more popular battery ever came into existence than the Ace, a fact that is substantiated by the preference shown this battery by thousands of radio users. The Ace has been found to be different from others—its higher voltage immediately impresses one with this individuality. Long life and excellent service bear out the reason for the higher voltage.

ACE RADIO "A" BATTERIES

For vacuum tubes requiring 1½ volts, the Ace is obtainable in several types of various cell power. The design of this battery is expressly for "A" circuit vacuum tube requirements.

ACE WIRELESS "B" BATTERIES

Made in several types from 16½ volts to 108 volts. Testimonials show that this battery is especially helpful in summer for obtaining messages without noisy distortion.

$.63 A three cell 1½ volt dry battery

The CARBON PRODUCTS CO.
LANCASTER OHIO

Manufacturers of Dry Batteries, Flashlights and Flashlight Batteries, Carbon Brushes, Projector Carbons and Welding Carbons

AMERICAN

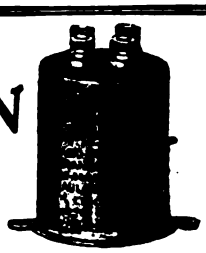
AMPLIFYING TRANSFORMERS
(Radio and Audio Frequency)

Give Wonderful Results

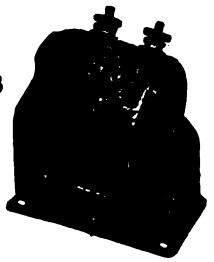
When Used In

"Neutrodyne" and "Reflex" Circuits

For best results with the "Neutrodyne" & "Reflex" Circuits, use "All-American" Radio frequency Amplifying Transformers. Type R-10 and Type R-13. Ratio 10 to 1 Audio Frequency Transformers.



RADIO FREQUENCY
R-10 (150-550 meters) $4.50



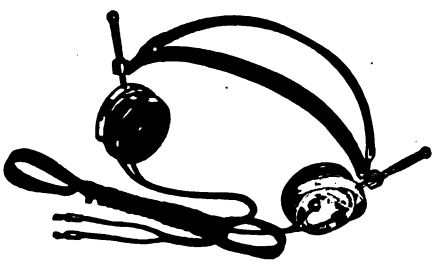
AUDIO FREQUENCY

R-12 (Ratio 3 to 1)	$4.50
R-21 (Ratio 5 to 1)	4.75
R-13 (Ratio 10 to 1)	4.75

Ask your dealer for FREE "All-American" Hand Book of Radio Hookups. If he cannot supply you, write us, sending two cent stamp for postage.

RAULAND MFG. CO.
200 No. Jefferson St., Chicago, Ill.

AMPL-TONE PHONES



2200 Ohms—$6.00

AT LAST, the public may have these EXCELLENT Headsets at a popular price. Positively the equal of the expensive phones, for beauty, comfort, tone and durability. Money back guarantee protects you. "Wonderful value," "Equal to $12.00 phones" and other testimonials on file.

Write for special prices for a limited period

DEALERS: Get in on our special advertising and extreme discounts. One sample for $3.00 cash.

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INSTRUMENT MAKERS

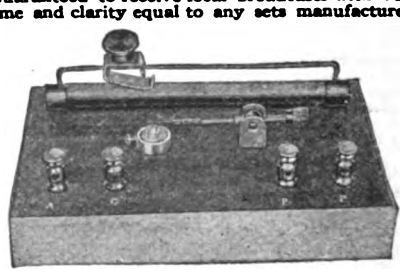
DEPENDABLE TESCO PRODUCTS

SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



TYPE "A" (Shown in cut) - - **$1.25**
TYPE "B" De Luxe - - $6.00

Type A, Complete with Phones and Aerial....$6.00
Type B, Complete with Phones and Aerial....11.00

Sent prepaid upon receipt of express or postal money orders.
Money refunded if not absolutely satisfactory.
Dealers and Jobbers write for discounts.

BOYS: You can make good money selling these sets. Write for terms.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.

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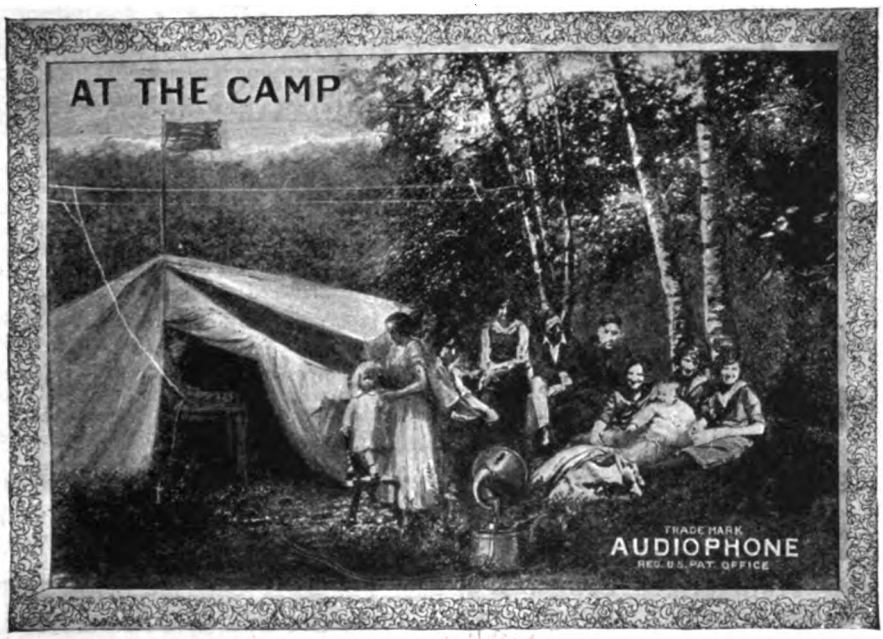

AUDIOPHONE AND CANOE
both go to camp

Nobody wants to wear head phones during hot, stuffy weather. A small efficient Loud Speaker ruggedly built will be welcome in any camp outfit. The AUDIOPHONE JR. is just the thing.

Brist l AUDIOPHONE made in two sizes—

Audiophone Sr.
Diameter of horn, 15 inches
Weight, 10 pounds
Price, $32.50

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Diameter of horn, 11 inches
Weight, 7 pounds
Price, $22.50

Bulletin 3006-L describes them.

Light in weight and easily assembled or dismantled without tools. Doesn't require any battery. The tone quality is exceptional and will give enough volume to entertain the whole camp party.

See it at your dealers or write direct.

THE BRISTOL COMPANY
Waterbury, Conn.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH DETROIT
CHICAGO ST. LOUIS SAN FRANCISCO

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In Any or All Stages
of audio frequency amplification

The AMERTRAN

Price $7

Ask your electrical dealer, or sent carriage charges collect. (Wt. 1 lb.)

can and should be used.

It is made in only one type and one ratio. **Its flat-top amplification curve precludes the possibility of distortion on the part of the transformer when used in any or all stages.**

It will give the same clear-toned distortionless amplification with all tubes which are approximately alike in A. C. Impedance and Amplification Factor, such as

WD-11, C-301,
WD-12, UV-201-A,
UV-199, C-301-A,
C-299, UV-201.

Its amplification in one stage is 38.6; two stages 1490

American Transformer Company
Designers and builders of radio transformers for over 20 years
175 Emmet St., Newark, N. J.

a Chi-Rad Special!

for W.D. 11 tubes–

Standard, threaded rubber, Willard's, specially adapted for use with W. D. 11 tubes. Supply current at 2 volts to one W.D. 11 tube for 210 hours on a single charge. Rechargeable. Brand new, size 4x5½x7 inches—Chi-Rad guaranteed.

2-Volt Willard Charged . . $7.50
2-Volt Willard Dry 6.50

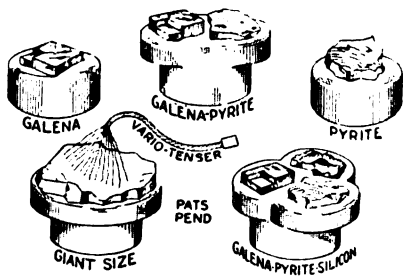
These same Willards can be adapted to deliver 8 volts for pure D. C. for C. W. Transmitters. Better than a generator because no filter is necessary. Much less expensive.

In lots of 40 (320 volts) $160.00

(Better prices on larger quantities.)

Specify dry or charged when ordering.

Chicago Radio Apparatus Co.
415 S. Dearborn St., Chicago, Ill.



Foote's Triple-Test Crystals

are guaranteed

Loud All Over or a New One

Triplets	$0.60
Twins	.50
Single Galena	.30
Single Pyrite	.30
Giant Pyrite, 6 times old size	.75
Giant Galena, 6 times old size	.75

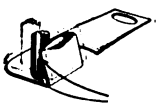
The "VARIO-TENSER"

A 14 Strand Solid Gold Cat-Whisker. Its brush tip varies and selects the best tension. No spot escapes. Rustless; flexible . . $0.50

FOOTE MINERAL CO., INC., Mfrs.
103 N. 19th St., Philadelphia

Mineral Pioneers for Nearly 50 Years

Na-ald Special Socket No. 499



Na-ald De Luxe No. 400

It's the contact that counts

The Na-ald Special Socket No. 499 is a sturdy little socket with a dependable contact for the G. E. No. 199 dry-cell tube. It has special slot construction, and is moulded of genuine Bakelite. The heat from soldering connections will not affect Na-ald sockets.

Price 50 cents
Na-ald Adapter for No. 199 tube, **$1.00**

The dual-wipe contact strips of the Na-ald De Luxe socket avoid the trouble experienced with the socket of conventional design. Because of thorough cure and high dielectric properties Na-ald sockets keep plate to grid losses at a minimum (of particular importance in Flewelling Circuit or in Radio Frequency).

Price 75 cents

Booklet with diagram of Haseltine's Neutrodyne Circuit and other selected circuits, packed with each Na-ald product or sent in exchange for cover taken from any Na-ald carton.

Alden Manufacturing Co.
Manufacturers of Sockets for Every Tube and Requirement
Dept. C 52 Willow St.
Springfield, Mass.

RADIO PRODUCTS NA-ALD

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The Symphony

The ability to select your entertainment from the various programs that are being broadcast, and the clarity with which long distance stations can be heard depend entirely on the quality of the receiving set.

The Symphony is an unusually good receiver. By turning a single knob under proper conditions, it is possible to tune in stations, one by one, to the total exclusion of all others.

This improved circuit, in the vernacular of the technical expert, is an improvement over the simgle circuit by means of a variometer, and affords unusually selective reception.

So efficient is the Symphony that its volume, at any stage, surpasses many sets, and is equal to many other receivers using additional stages of amplification.

Every piece of apparatus that goes into the Symphony is the best that can be produced, and each unit is correctly mounted in proper relation to each other part, factors that play an important part in your satisfaction of radio.

The placing of a Symphony in your home is a permanent investment that will win your instant approval, and occupy a prominent place among your cherished possessions.

The Symphony Receivers are made in two types—detector, and two or three stages of audio frequency amplification.

If your dealer cannot furnish information on the Symphony, wire or write for illustrated catalog, giving us his name.

JONES RADIO COMPANY

Lytton Building, Chicago

The Symphony is manufactured under the U. S. Patent No. 1113149, Armstrong Regenerative Circuit

All parts used in the Symphony are built and guaranteed by the Kellogg Switchboard & Supply Company manufacturers for twenty-five years of complete telephone equipment

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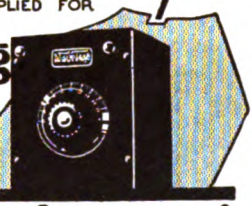
TRADE MARK

Wave Trap

PATENT APPLIED FOR

The Missing Link in RADIO



Stops Interference!

The "WAVE TRAP" will eliminate interfering broadcasting stations and enable you to listen to your favorite station.

It will work on any set, greatly increase its selectivity and clearness, and eliminate code and spark stations.

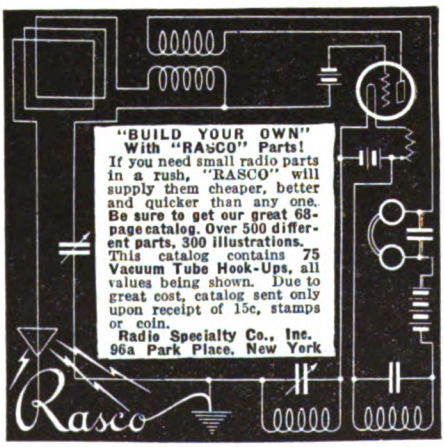
It is mounted on a Formica panel in a handsome mahogany finished cabinet 6x5x6. It is a high grade instrument throughout and a valuable addition to the operation and appearance of any set. It comes to you complete and there are no extras to buy. It is installed in a minute by changing only one outside connection.

Use the "WAVE TRAP" for real results.

8.50 CHARGES PREPAID

Ferbend Electric Co.
21 E. SOUTH WATER ST.
CHICAGO

Circular on request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With "RASCO" Parts!
If you need small radio parts in a rush, "RASCO" will supply them cheaper, better and quicker than any one. Be sure to get our great 68-page catalog. Over 500 different parts, 300 illustrations. This catalog contains 75 Vacuum Tube Hook-Ups, all values being shown. Due to great cost, catalog sent only upon receipt of 15c, stamps or coin.
Radio Specialty Co., Inc.
96a Park Place, New York
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Worth Sending For!

Circular describing Rheostat construction is sent free of charge upon request. Explains cut-out switch, constant contact principle, and minute adjustment of UNITY Vernier Rheostat. Write for it *now.*

THE UNITY MANUFACTURING COMPANY
224 N. Halsted St., Chicago

RUSONITE

CRYSTAL RECTIFIER

MULTIPOINT
(Patent Pending)

A Synthetic CRYSTAL DETECTOR sensitive over its entire surface

Eliminates all detector troubles. Extraordinary clearness and volume. Endorsed by radio experts and press. Sold in sealed packages only. Join the ever-increasing Rusonite fans.

Price, mounted..... 50c
Sensitiveness guaranteed
RUSONITE CATWHISKER
14-Karat Gold Multiple contact. 25c
Supersensitive.....

Order from your dealer or direct from us.

Rusonite Products Corp., Dept. "P," 15 Park Row, N. Y.

LEARN RADIO

Here's your opportunity. Radio needs you. Win success in this fascinating field. Trained men in demand at highest salaries. Learn at home, in your spare time.

Be a Radio Expert

I will train you, quickly and easily, to design, construct, install, operate, repair, maintain, and sell all forms of Radio apparatus. My new methods are the most successful in existence. Learn to earn

$1,800 to $10,000 a Year

FREE Wonderful, home-construction, tube receiving set, of latest design.

Write for "Radio Facts" free. Engineer Mohaupt.

American Electrical Association
Dept. 57 4513 Ravenswood Ave., Chicago

Cockaday Circuit TUNER COILS

Complete B C D coils as per specifications.

No. 18 Wire Used—D Coil Bankwound. Price, $2.75

Hook-up, directions and material list furnished free with each set of coils.

MAIL ORDERS FILLED

Dealers, Communicate

Eastern Radio Mfg. Co.
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DON'T

BUY YOUR RADIO EQUIPMENT UNTIL YOU HAVE SENT FOR OUR PRICE LIST

It Will Pay You To Write

Cut Rate Radio Co.

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With connecting cord and full instructions **$25**

Lifelike Re-PRODUCTION

ALMOST as though from the throat of the artist in the distant studio, float the vibrant tones of the song, actually Re-PRODUCED, created anew, faultlessly duplicated through the marvelous musical-radio instrument, the *Atlas Amplitone*. Does *not* blast or distort.

Adjustable double diaphragm fits the *Amplitone* to your set and the individual receiving conditions.

Made like a fine musical instrument by the joint study and skill of acoustic and radio engineers. In every respect, worthy of your confidence.

Atlas AMPLITONE
LOUD SPEAKER

Insist Upon the Atlas Amplitone

Only the Atlas Amplitone can Re-PRODUCE. If your dealer has none, ask him to order for you.

Atlas Amplitone Unit

The Atlas Amplitone, minus the horn and base, can be purchased separately for use with your own horn or for attachment to any phonograph (except the Brunswick) with phonograph attachment **$13.50**

Unit without attachment $12.50

Write for Atlas Amplitone Book

This fully illustrated book describing this greatly advanced loud speaker and including a list of broadcasting stations, directions for improving reception, and the proper use of a loud speaker, and other valuable information from a widely known expert sent upon request.

Multiple Electric Products Co., Inc.

Radio Division

7 Orange Street **Newark, N. J.**

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This Offer of Premiums Holds Good Until July 30th!

Get the parts you want for your set—and get them FREE—by taking a few subscriptions for POPULAR RADIO from your friends.

If you've never tried it, you don't know how easy it is to get subscriptions for POPULAR RADIO. Just show this copy to some of your friends. Let the magazine sell itself to them. Then send us their names, with $2 for each yearly subscription, and take your choice of any of the following radio parts. They'll come to you *free* as a reward for your efforts.

Any One of These for 2 Subscriptions:

Dubilier Ducon
Dubilier Tubular Grid Leak (any standard size) with Grid Condenser .00025 mfd.
DeForest Vacuum Tube Socket with Bingo Rheostat
DeForest Potentiometer
Teleradio Lightning Arrestor with 50 feet of No. 14 r.c. lead-in wire and ground clamp
100 feet of stranded phosphor bronze aerial wire with 2 Electrose Insulators
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Diode Dry Cell Vacuum Tube

Your Choice for Only 5 Subscriptions:

Jefferson Audio Frequency Transformer (new style)
23 Plate Teleradio Variable Condenser, unmounted, with Alden-Napier 3 inch Dial
Set of DeForest Honeycomb Coils (Mounted) No. 35, No. 50 and No. 75
Phono-Phane Fixed Crystal Detector
Bakelite Panel, size 7 x 24 inches

Big Values for 8 Subscriptions each:

Manhattan Genuine Bakelite Variocoupler
Manhattan Genuine Bakelite Variometer
Radiotron U. V. 200 and C. H. Vernier Rheostat
DeForest 3-Coil Honeycomb Mounting
R. C. A. Radio Frequency Transformer
U. V. 201 Vacuum Tube
Post Electric Soldering Iron
Manhattan Headset (3000 ohms)

Free with 10 Subscriptions each:

43 Plate United States Tool Vernier Type Variable Condenser
Brandes Phones
Atwater Kent Detector Unit. Complete with 22½ volt Ever Ready B. Battery
Moon Radio Horn
Atwater Kent Variocoupler
Atwater Kent Variometer

If you want some particular part that isn't listed here, write us and we'll tell you how many subscriptions you'll need to get it free. We'll tell you, also, how you can earn a complete Cockaday 4-Circuit Tuner *free*. Or you can get an Exide Storage Battery, type 3-LXL-9, 80 amp. hr. 6 volt, for only 25 subscriptions! Renewals count just as much as new subscriptions. A two-year subscription for $4.00 counts the same as *two* one-year subscriptions.

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Radak

Is Insulated with Formica

THE Radak radio equipment manufactured by Clapp-Eastham of Cambridge, Mass., and sold everywhere is made with Formica panels and other Formica insulating parts.

This well-known line has genuine prestige in the radio industry. It is sold and known everywhere—and its endorsement of Formica is a matter of moment to every dealer and amateur.

The judgment of Clapp-Eastham Engineers in selecting Formica is supported by practically all the leading independent radio concerns, who likewise use it.

Formica is the best looking, the most uniform, the most efficient laminated phenolic material for radio uses

DEALERS: The Formica Insulation Company supports you with responsive and helpful service and the most aggressive advertising and sales campaign in the industry. Formica dealers can supply you promptly with panels in all standard sizes. They can also supply special sizes when you want them.

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FORMICA
Made from Anhydrous Redmanol Resins
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3200 OHMS, $9.50
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Coryphone "Loud Speaker" with Adjustable Feature, $40

Coryphone "Master Tone" The Loud Speaker Jr., $22

The world's finest reproducers. Coryphones have many exclusive features and are best by comparison. Ask your dealer to demonstrate these remarkable values.

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ESTABLISHED DEALERS EVERYWHERE
If your local dealer cannot supply you order through him or send order and remittance direct to us

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PHILADELPHIA The Bourse — BOSTON 88 Broad St. — SAN FRANCISCO 11 Mission St.
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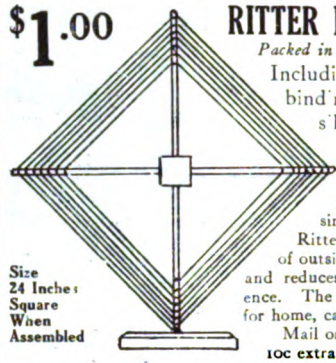
$1.00 RITTER LOOP AERIAL

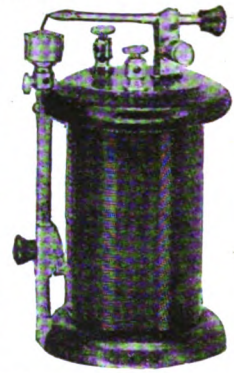
Packed in Individual Boxes



Size 24 Inches Square When Assembled

Including all wood parts, binding posts and green silk covered wire. Can be assembled in 10 minutes. Wonderful results obtained even with single tube sets. The Ritter Loop eliminates use of outside aerial and ground, and reduces static and interference. The Ritter Loop is good for home, camp or automobile. Mail orders filled. Postage 10c extra.

CRYSTAL SET $3.50



The Ritter Grand Crystal Set will tune up to 600 meters and receive all concerts within 25 to 35 miles. Beautiful mahogany finish, 6 in. high, 3½ in. diameter.

Free circular on how to erect your aerial sent upon request.

Jobbers and dealers who want these two quick selling radio items should communicate with

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232 Canal Street, New York City

A-C DAYTON

RADIO PRODUCTS

This trade mark is a symbol of quality in Radio parts.

A. C. ELECTRICAL MFG. CO.
Dayton, Ohio

MOON RECEIVING SETS

THE MOON RADIO CORPORATION

Manufacturers of
Ultra-fine Receiving Sets
12 Diagonal Street
Long Island City, N. Y.

SPECIAL OFFER

Two new yearly subscriptions to POPULAR RADIO for only .... $3.

Rope this Special Offer! Any Radio enthusiast can do it. You and a friend of yours may have POPULAR RADIO for a whole year, provided you are both NEW subscribers. You only have to throw a check for $3 around the double coupon and MAIL IT TO-DAY.

(Coupon good until July 20th, 1923)

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9 East 40th Street, New York City
Please send POPULAR RADIO for one year to:

NAME.....
ADDRESS.....
CITY.....STATE.....

And also to this other new subscriber. Here's my cash remittance—(or a check or money order for $3).

NAME.....
ADDRESS.....
CITY.....STATE.....

(No extra for Canada. Foreign countries 25 cents extra per subscription.)

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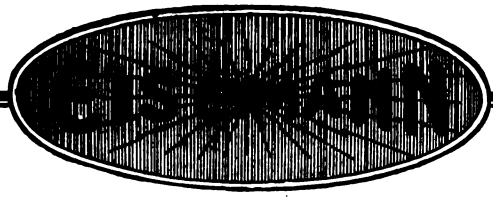
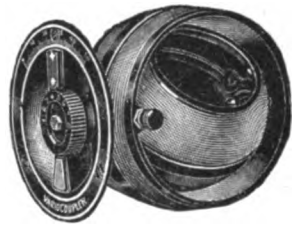


VARIOMETER

CONDENSER

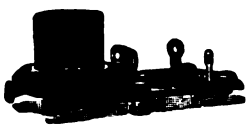


VARIOCOUPLER

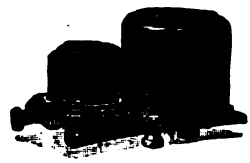
THROUGH the use of Eisemann units and panels the assembly of a receiving set entails less than half the labor customarily involved.

The panels illustrated below are completely drilled and ready for use. The units are simply bolted to the panels—the only tool required being a small screw driver. The panels are of aluminum, which acts as a body capacity shield, and have a crystal black finish.

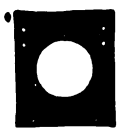
Variometers, variocouplers and condensers, with their matched recessed dials, fit interchangeably into the large circular openings. The rheostat wheels surrounding the sockets on detector and amplifier units extend through the rectangular holes in lower half of panels.



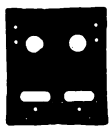
DETECTOR UNIT



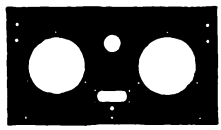
AUDIO AMPLIFIER UNIT



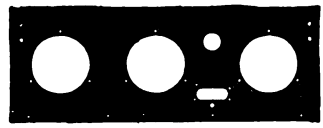
T-1



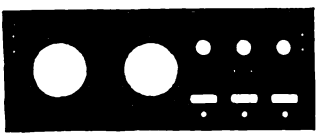
A-2



TD-2

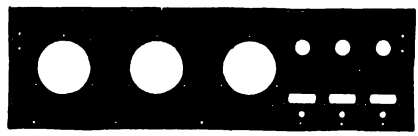


TD-3



TD-2A

METAL PANELS



TD-3A

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DETROIT CHICAGO SAN FRANCISCO

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Send us your burned out or broken Detectors or Amplifiers and receive maximum allowance on the purchase of NEW TUBES.

UNLIMITED QUANTITY ALWAYS ON HAND FOR IMMEDIATE SHIPMENT.

We allow you Seventy-five Cents on an old UV200 in the purchase of a new one and One Dollar on WD11 and 12 when buying new Tubes, corresponding allowances on all makes. One allowance on each purchase.

Radio Tubes Repaired in One Week

Customers who purchase new tubes from us are entitled to a special discount on repair work. In other words we sell you new tubes and then keep them in shape for you.

We also usually have on hand a quantity of uncalled-for refilled, licensed tubes at very moderate prices, *all guaranteed*.

OUR REPAIRED TUBES SPEAK FOR THEMSELVES.

Write to-day for Circular P7 which will explain all the details.

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Vacuum Tube Specialists

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SPECIAL BARGAIN

WONDERFUL TUBE SET 1000 MILE RANGE . . 18.00

Newark Can Get Davenport, Iowa

Free—one pair $8.00 Everett Phones with each set purchased

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VARIABLE CONDENSERS

Bakelite End Plates		Standard Construction	
3 Plate	$1.25	21 Plate	$1.75
11 "	1.50	43 "	2.25

Enclose Money Order and Goods will be Shipped Immediately by Parcel Post, Postage C.O.D.

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World Radio Batteries SAVE YOU 50%

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In buying a WORLD, the highest quality battery built, direct from the manufacturer, you gain two profits. First: you get a battery free from extravagant selling expense. Second: you get the profit charged by the middle-man. You take no risk. We ship express C. O. D. subject to your inspection, or will allow five per cent for cash with order. Mail your order today!

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RADIO PRICES:	
6 Volt. 60 Amps.	$10.00
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No other manufacturer offers such a high quality battery at such a low price. Save 50 per cent on your next battery and get better and longer service—buy a **World Storage Radio Battery.** Write today.

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GUARANTEED one year. Sent anywhere in U.S. or Canada Parcel Post prepaid on receipt of money order for $2.28.

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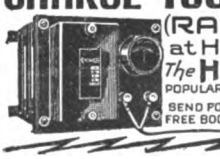

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For tube sets, use our special Adaptor, 75c extra. To convert crystal sets into tube sets, use special socket, 40c extra.

RADIO RESEARCH GUILD

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The SP2 Receiver Has "That Something"—

A Receiver that can be demonstrated with a world of satisfaction and sold with remarkable ease.

The SP2 is everything the radio-receiver purchaser anticipates in the ideal set of his fancy.

It brings in the local stations in all the fullness and clearness of the actual performance of the sender. Stations, broadcasting simultaneously, are tuned in and cut out at pleasure, readily and surely.

Noise and disturbance are practically eliminated. The SP2 is listened to with genuine delight. It gives a QUALITY performance; the entertainment as afforded by broadcasting stations EVERYWHERE—and **at its** best.

Long distance stations come in on the SP2 **clearly** and **distinctly** even to the "faintest" signals that mark the range of a highly efficient receiving set.

The SP2 Receiver has an unlimited range and is nationally known for its compactness of size, elegance of appearance, superiority of quality and scientific perfection.

Retails at $100

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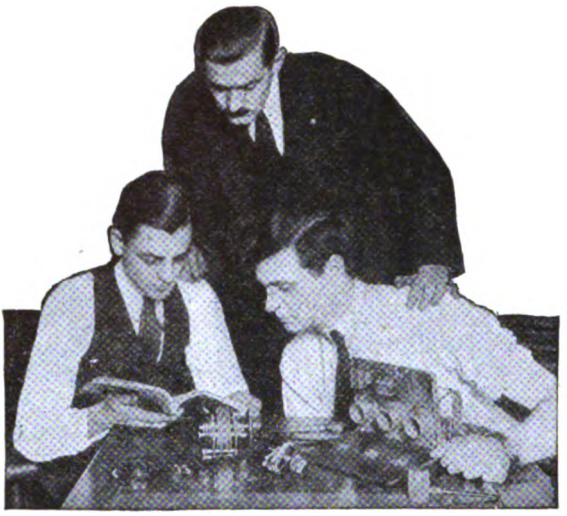

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Largest Radio Store in America

Build Your Own Set

According to Our Instructions

RESULTS GUARANTEED

The panel on each set is drilled—ready to mount

Largest Radio Store in America

Complete Parts for Knocked-Down Receiving Sets $17.95

CONSISTING OF	Reg. Price	Our Price
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1 Variocoupler	5.00	1.75
3 Bakelite Dials	3.00	.75
Bakelite Socket	1.00	.45
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C-300 Detector Tube	5.00	4.45
Mahogany Cabinet	4.50	2.75
Genuine Formica Panel	2.25	1.75
8 Binding Posts	.80	.40
Switch Lever	.50	.25
12 Switch Points	.40	.20
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Complete Drawing for Assembly and Wiring	1.00	.50
Regular Price	$30.85	
Our Price		$17.95

Complete Parts for Reinartz Sets $11.45

CONSISTING OF	Reg. Price	Our Price
7x18 Formica Panel	$1.89	$1.70
Remler Bakelite Socket	1.00	.45
Vernier Rheostat	1.50	1.35
23 Plate Variable Condenser	3.30	1.45
11 Plate Cuni Variable	3.10	1.35
3 Switch Levers	1.50	.75
2 Dozen Switch Points	.80	.40
1 Schoonhoven Reinarts Coil	3.00	1.95
Variable Grid Leak and Condenser Combined	1.00	.75
8 Binding Posts	.80	.40
25 Feet Tinned Wire	.30	.20
Baseboard for Mounting	.50	.25
Blueprint with Complete Instructions for Assembly and Wiring	1.00	.50
Regular Price	$21.69	
Our Price		$11.45

Complete Parts for 2-Step Amplifier $12.45

Can be used to amplify Reinartz, Flewelling, Short Wave Receiver, Crystal, Ultra Audion or any Receiving Set so that Loud Speaker or Phonograph can be used in place of head set.

CONSISTING OF	Reg. Price	Our Price
7x10 Formica Panel or Other Suitable Size	$1.05	$0.80
High Ratio Transformer	4.75	3.95
Low Ratio Transformer	4.50	2.95
2 Rheostats	2.20	2.00
2 Bakelite Sockets	2.00	.90
3 Double Jacks	3.00	1.50
13 Binding Posts	1.30	.65
Baseboard for Mounting	.30	.15
Regular Price	$20.00	
Wiring Diagram, with Complete Instructions for Drilling and Assembling Panel		
Our Price		$12.45

$10 VALUE LONG RANGE HEADSET $3.65

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Type C unit 3.95
Brandes superior headset 5.75
3,000 Ohm Guaranteed Headsets $8.50 value. 3.65

Complete Parts for Flewelling Circuit $12.45

CONSISTING OF	Reg. Price	Our Price
6x14 Formica Panel	$1.26	$1.10
23 Plate Variable Condenser	3.30	1.45
Three .006 Mica Condensers	3.00	2.25
CRL Variable Grid Leak	1.85	1.35
Grid Leak	.40	.25
2 Coil Adjustable Honeycomb Coil Mounting with Knobs	4.00	2.65
50 Turn Honeycomb Coil	.75	.40
75 Turn Honeycomb Coil	.80	.40
2 Coil Mounts with Straps	1.20	.80
1 Bakelite Socket	1.00	.45
Vernier Rheostat	1.50	1.35
1 Bakelite 3" Dial	1.00	.25
8 Binding Posts	.80	.40
1 Baseboard for Mounting	.30	.20
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Regular Price	$22.16	
Our Price		$12.45

Complete Parts for Ultra Audion Circuit $11.90

(Known as the Wonder Circuit)

CONSISTING OF	Reg. Price	Our Price
9x10½ Formica Panel	$1.42	$1.20
23-Plate Condenser	3.30	1.45
Bakelite Socket (Remler)	1.00	.45
Special Ultra Audion Coil, plain or bank wound with tape	3.00	1.95
1 Vernier Rheostat	1.50	1.35
CRL Grid Leak	1.50	.95
.0005 Micon Condenser	.35	.25
2 Switch Levers	.70	.50
18 Switch Points	.50	.30
2 Switch Stops	.10	.05
8 Binding Posts	.80	.40
Genuine Solid Mahogany Cabinet, size 9x10½, with hinged top	5.00	2.95
25-ft Hookup Wire	.20	.10
Regular Price	$19.37	

Each order includes complete instructions for drilling, assembling and wiring. These construction plans are not drawn in a schematic form but are drawn so that any one without any technical knowledge can follow with ease.

Our Price $11.90

Complete Parts for Single Tube Reflex Circuit $32.65

CONSISTING OF	Reg. Price	Our Price
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Radion Loop Aerial	8.50	5.95
Cunningham C301-A Tube	9.00	5.95
Grewol Glass Inclosed Detector	2.00	1.65
Radio Frequency Transformer	5.00	3.45
5 to 1 Radio Audio Frequency Transformer	4.75	3.95
2—.001 Micon Condensers	.70	.50
1—.002 Micon Condenser	.45	.35
Potentiometer	1.50	1.35
25 Ohm Rheostat	1.10	1.00
8 Binding Posts	.80	.40
9x10½ Formica Panel	1.42	1.20
9x10½ Genuine Solid Mahogany Cabinet with hinged top	5.00	2.95

Complete instructions for drilling, assembling and wiring furnished so that any one with no technical knowledge can easily follow. Regular price, $45.22.

Our Price $32.65

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Especially adapted to radio work. Simply attach to any light socket 110-120 volts. Complete, with six foot cord and attaching plug. Lasts a lifetime for ordinary home or light shop work. A real bargain.

FORMICA PANEL

Black or Brown cut to size

⅛ in. thick

SQ. IN. 1 1/2c

3/6 IN. 2c

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"POPULAR RADIO" and "RADIO" (San Francisco) known the nation over for the wealth of practical information they contain, in addition to a mass of most timely radio news, valuable constructional data for those who "roll their own," feature articles by the leaders of the industry, the latest radio developments and discussions on everything worth-while talking about, have joined forces in a great money-saving clubbing offer in order to give *you* these leading two radio publications at a cost very little more than the subscription price of either magazine alone. Just imagine—you can subscribe to *both* "POPULAR RADIO" and "RADIO" for a full year for only $3.00—a saving to you of $1.50 over what you would pay for them separately.

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Send me "POPULAR RADIO" and "RADIO" for one full year. I enclose $3.00.

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Here's the little coupon that will save you big money if you mail it before July 20th.

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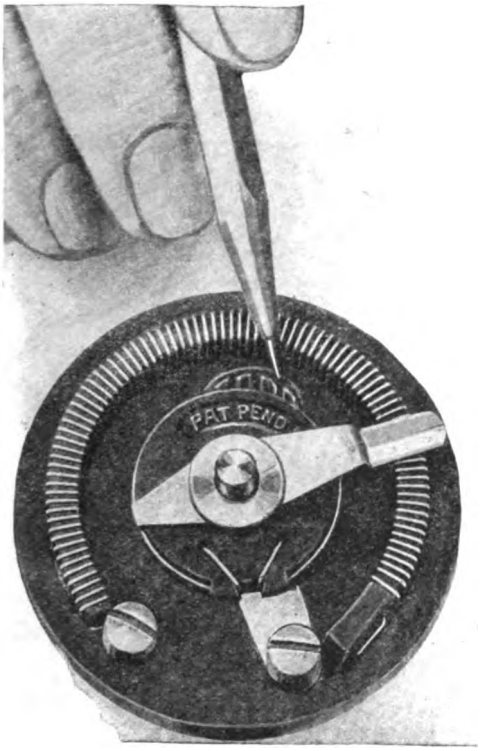

Fada Rheostats and Potentiometers

are favorites with radiophans who construct their own receivers

120-A 5 ohms plain Rheostat for all 6 volt tubes	$0.75
121-A Power Rheostat for three or four tubes in parallel	1.20
150-A 5 ohm vernier Rheostat for best control of 6 volt detector tubes	1.25
151-A Vernier attachment. Instantly converts almost any 3-16" shaft Rheostat into vernier type	0.50
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Send 10c for the FADA Handbook and Bulletin about the FADA "ONE-SIXTY"

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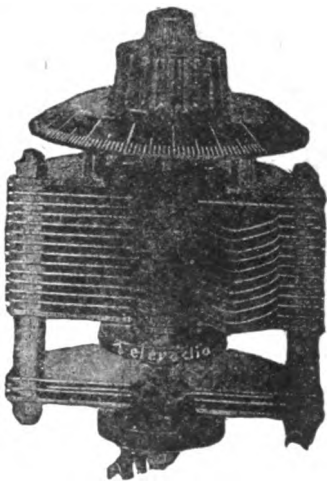
(TRADE-MARK)

Another High Grade Instrument Has Been Added to the Popular "TELERADIO" Line of Wireless Equipment

Guaranteed Electrically and Mechanically Perfect



New Improved Vernier Variable Condenser

Makes Fine Tuning a Pleasure
All Metal Parts Nickel Plated

23 Plate $4.50 **43 Plate $5.50**

Supersensitive Headsets

Accurately reproduce the faintest signals on either crystal or tube sets and bring in voice or music with wonderful tonal quality. Equally satisfactory for local or distance work.

2000 Ohms	2200 Ohms	3000 Ohms
$6.50	$7.50	$9.00

Jobbers and Dealers Write for Our Attractive Proposition

Prize winners of "Stay Sold" Contest Announced in March Issue

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2nd—VERNON B. DAVIS, Denver, Colo.
3rd—CHARLES DUMMETT, Millville, N. J.

Teleradio Engineering Corp.

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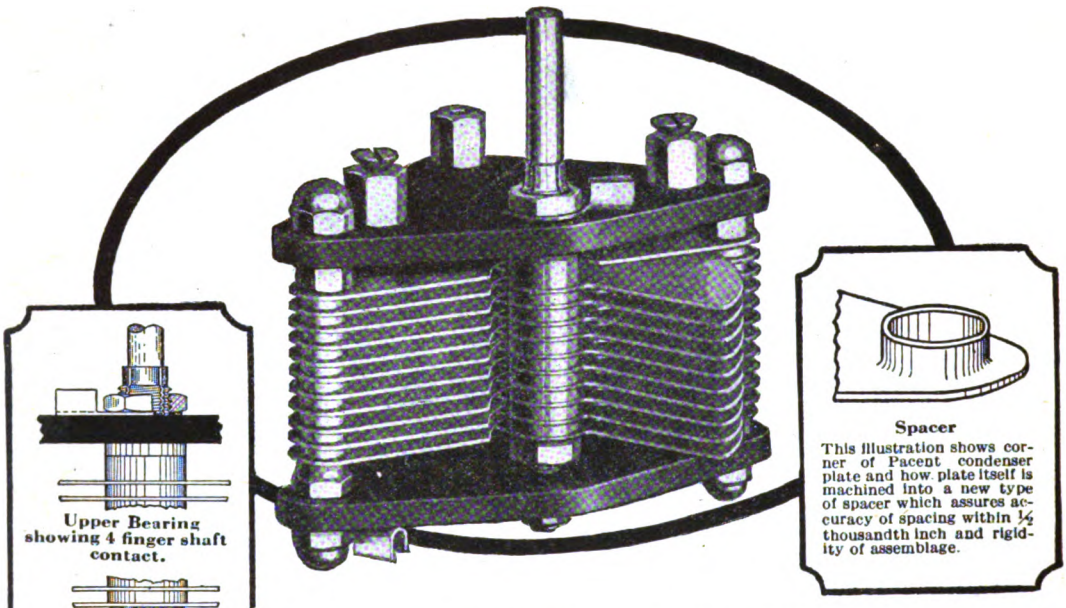

Upper Bearing showing 4 finger shaft contact.

Lower Adjustable Bearing

Spacer

This illustration shows corner of Pacent condenser plate and how plate itself is machined into a new type of spacer which assures accuracy of spacing within ½ thousandth inch and rigidity of assemblage.

PACENT CONDENSER

SUPER-QUALITY

NO man ever regretted paying the price for quality. Pacent Condensers are an example of extreme quality at reasonable prices.

Some outstanding points of superiority of the Pacent Condenser are:

1. Elimination of washer separators—plates themselves machined into spacers.
2. Improved bearings—adjustable—including 4 finger contact with shaft.
3. Longer wave length range.
4. Lower resistance—more selectivity.
5. Quality throughout—Genuine bakelite heads, extra heavy aluminum plates, brass parts heavily nickeled.
6. Endorsed by leading engineers—Standard with large manufacturers.

The superior service which you will get from a Pacent Condenser is worth twice the price.

No. 200A—	3 plate	.00007	Micro	Farad	$2.75
No. 200B—	5 "	.00012	"	"	3.00
No. 200C—	11 "	.00025	"	"	3.25
No. 200D—	21 "	.0005	"	"	3.75
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PACENT ELECTRIC CO., Inc., 22 Park Place, New York

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WRITE FOR DESCRIPTIVE BULLETINS P-7

Don't Improvise—"PACENTIZE"

Pacent

RADIO ESSENTIALS

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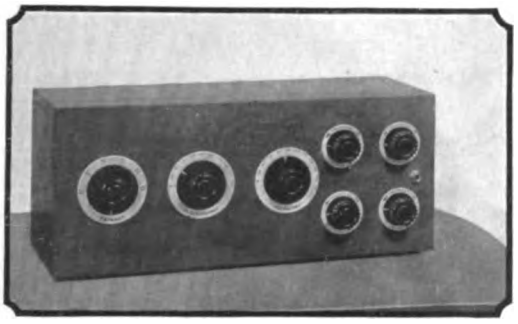
the future of the business of RADIO

from the standpoint of

the user—

depends largely upon the efficiency, dependability and simplicity of the receiver he buys



Receiver 11A—Leader of the C & W Line

It is for this reason that we believe Cutting & Washington Receivers to be years ahead in radio.

Designed by Dr. Fulton Cutting and Mr. Bowden Washington, whose apparatus is used by the Ships, Aeroplanes and Shore Stations of the United States Government, built by one of the world's largest manufacturers of automatic electric equipment, C. & W. Receivers bring a new simplicity and sturdiness to radio construction.

If you want dependable operation without annoyance and troublesome service, you want a Cutting & Washington Receiver. Write for literature. See how the Famous Armstrong Regenerative Circuit plus excellent design is incorporated in C. & W. Sets.

and the dealer—

upon building a reputation for sterling quality in his equipment and service

The Radio business is changing from a wild craze to the steady buying of a marvelous means of entertainment and recreation. This means better, more sound business ahead for every good dealer in the field.

It also means that you should choose your apparatus and the company that makes it carefully:

1. Cutting & Washington Radio Corporation are America's oldest manufacturers of commercial radio equipment, with practically unlimited resources available.
2. Cutting & Washington apparatus (licensed under Armstrong Patents) combines a simplicity and excellence of workmanship that permits you to *prove* it is *right*.
3. Dealers are provided with *tested* local advertising,and selling plan to cut sales costs.
4. Complete servicing plan insures satisfactory operation of apparatus.
5. Complete line of instruments and new merchandising plan that covers every phase of a profitable business in radio.

Free Book

"The Future of Radio Retailing" sent to all radio dealers on request. Valuable information. Write for your copy.

Cutting and Washington

America's Oldest Manufacturers of Commercial Radio

Radio Corporation

Minneapolis, Minnesota

Practically Unlimited Available Resources

PRESS OF WILLIAM GREEN, NEW YORK

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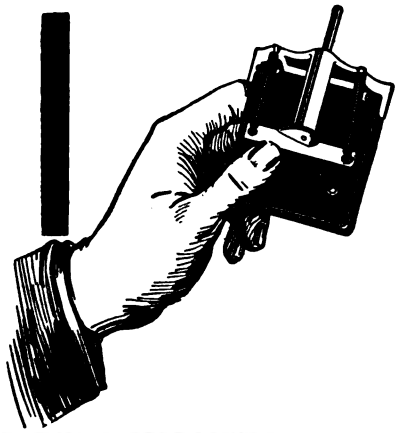


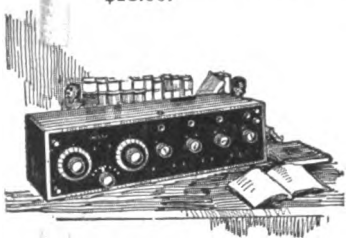
Just one Reason why CROSLEY RADIO RECEIVERS are *so much better*

The heart of any receiver is the variable condenser. The superiority of the Crosley book-type variable condenser over the old type interlocking plate air condenser is now generally admitted for the following reasons:

1. Rugged construction that prevents damage.
2. Freedom from short circuits.
3. Permanent metallic contact with plates eliminates sliding contacts.
4. Minimum stray electrostatic field eliminates body effects when tuning.
5. Liberal leakage paths through condenser.
6. Grounded frame provides electrostatic shield.
7. Minimum high frequency resistance or energy loss.
8. Maximum variation in wave length with fixed coil.
9. Maximum mechanical and electrical efficiency.
10. Minimum cost.

We state positively that the substitution of a Crosley condenser for any other type of commercial receiving condenser in any receiving set or circuit will greatly increase the range, volume and simplicity of tuning.

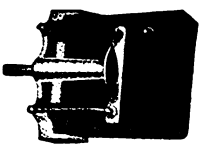
The justly famous Crosley Model VI, a two tube set incorporating one stage of tuned radio frequency amplification and detector, price—$28.00.



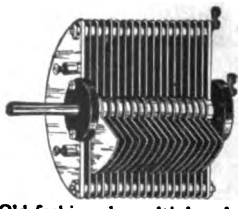
The standard Model X that has made history during the past year, and is now recognized as the most efficient set on the market, will be continued at the same price—$55.00, notwithstanding the advanced cost of materials.

We announce a new Model X, to be designated as Model X-J, equipped with head phone jacks for detector and one stage of amplification, in addition to loud speaker binding posts.

The instrument has been redesigned internally with new molded sockets, condensers having molded plates, rheostats in molded shells, new dials, price—$65.00.



New Crosley type D condenser has molded plates. Price $2.25.



Old-fashioned multiple plate condenser which has been largely replaced by Crosley type D.

New York Office, C. B. COOPER, 1803 Tribune Bldg., 154 Nassau St.
Boston Office, B. H. SMITH, 929 Blue Hill Ave., Dorchester
Chicago Office, 1311 Steger Bldg., 28 E. Jackson Blvd., R. A. STEMM, Mgr.

Crosley receivers incorporating tuned radio frequency amplication reduce static and other interference to a wonderful degree, which greatly increases summer receiving range.

CROSLEY MANUFACTURING CO.

716 ALFRED STREET CINCINNATI, OHIO

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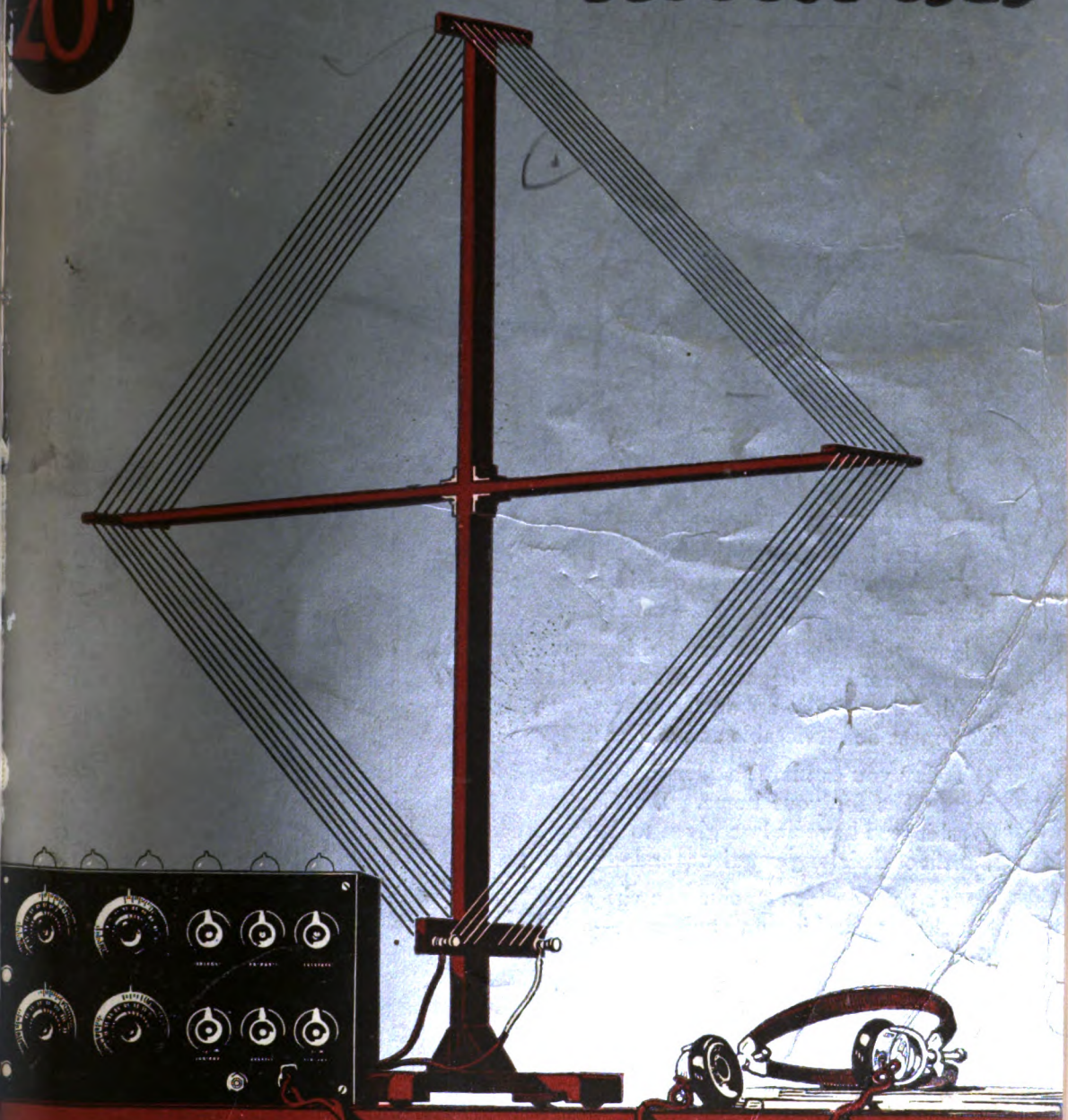
Popular Radio

20¢

AUGUST · 1923



The Winning Fight Against Static

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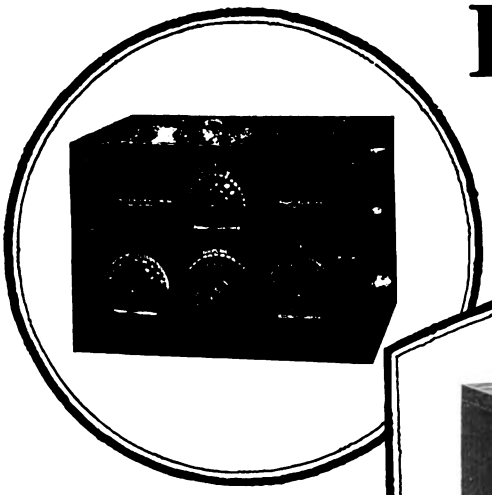
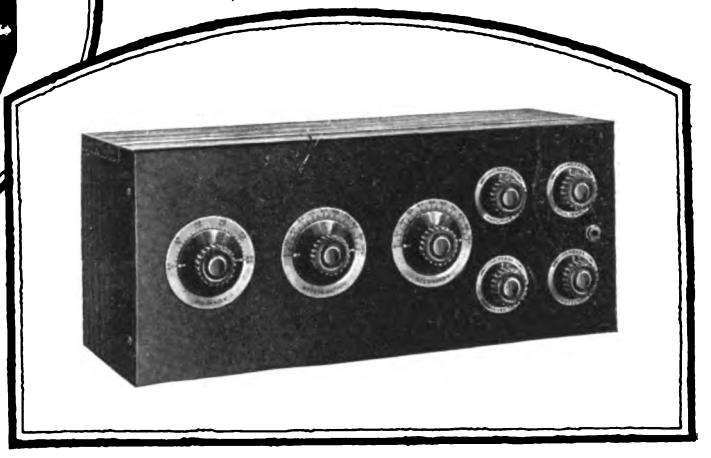
Radio in 1914



1914 model, Cutting & Washington Receiver, one of the first commercial sets in America, and—

A present Cutting & Washington model, the standard for simplicity and sound design.



and today

THROUGHOUT their long experience of Radio, Dr. Fulton Cutting and Mr. Bowden Washington have kept to one idea—make Radio simple—make it dependable—make it useful.

How well they have succeeded is proved by their famous record as designers of U. S. Naval and Marine Equipment—Radio apparatus that *must* not fail—that must be serviceable and efficient.

Today you can have a genuine Cutting & Washington Set for your home. Dr. Cutting and Mr. Washington have at last given to Home Radio the benefit of their long experience and expert engineering.

Ask your dealer to point out the superiorities of Cutting & Washington equipment—or write direct for illustrated catalog.

Cutting & Washington Radio Corp.
Minneapolis, Minnesota

Dealers

C & W Sets are so simple and efficient that you can easily *prove* they are the sets for your customers to own. They are:

1. Designed under Armstrong Patents.
2. By America's Pioneer Radio Manufacturers.
3. Built by world's largest makers of automatic electric equipment.

Write for "The Future of Radio Retailing", a book that outlines the liberal franchise offered C & W Dealers, and the C & W plan for a profitable business in Radio.

Cutting and Washington

America's Oldest Manufacturers of Commercial Radio

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Brandes

This man knows Radio!

HE knows how to get the *best* out of his set. New hook-ups, new tubes, new parts—he tests them all and finds the best.

He was a wireless fan long before radio became the greatest indoor sport. Fifteen years ago he used Brandes. Today he still sticks to his Brandes *Matched Tone* Headset.

He knows that its *Matched Tone* assures clear and harmonious reception of the worldful of interesting news which his set picks up. He gets it all—perfectly—with a Brandes.

Made in Canada and England by
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Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(*Cover design by Frank B. Masters*)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

For advertising rates address E. R. CROWE & Co.
New York: 9 East 40th St. Chicago: 645 North Michigan Ave.

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"Fame is the follower of reality." Yu Tse.

the New Grebe

Broadcast Receiver earns great fame through superior performance. Doctor Mu.

Seven Points of Satisfaction.

1. Requires no outdoor antenna—no loop.
2. Uses all kinds of tubes (4 of them) in any desired combination.
3. Employs the perfect combination of Regeneration and Tuned Radio Frequency Amplification with only two tuning adjustments.
4. Receives all broadcasting.
5. Tuning Dial graduated in wavelengths.
6. May be set up immediately, and successfully operated—anywhere—by anyone.
7. Complete, self-contained Receiver, in attractively finished walnut cabinet, with compartments for A and B batteries.

Write for Booklet

GREBE RADIO

A. H. GREBE & COMPANY, Inc.
Richmond Hill, N.Y.
Western Branch, 431 East 3rd St., Los Angeles, Cal.

Licensed under Armstrong U. S. Pat. No. 1,113,149

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PAGES WITH THE EDITOR

REPORTS of the remarkable success of our Technical Editor's newest invention, the famous Cockaday Four-Circuit Tuner, continue to come not only from all over the United States but also from Canada, Mexico and now from England and Europe. One of the most impressive of these returns came from a group of typically alert fans down in Texas.

* * *

So intense was the interest of the amateurs of Waco in Mr. Cockaday's description of his receiver (in the May, 1923, issue) that they selected one of their number to make the journey all the way from Texas to the office of POPULAR RADIO and to obtain at first hand from the inventor all of the very latest working data that might be of value to them. And when Mr. Carl Bergstrom of Waco, walked unexpectedly into our office in New York, Mr. Cockaday laid aside his other work and filled up his visitor with enough "tips" about the new set to keep his Texas associates satisfied for some time to come.

* * *

WOULD you like to know what some of these "very latest working data" are? Turn to our *What Readers Ask* department in this number and you will find some of it; more will appear in our September and subsequent issues. Mr. Cockaday's experimental work in his laboratory is constantly revealing new and better ways for getting the most out of your apparatus, and this information is being, and will continue to be printed in the form of short, helpful, practical items in our departments.

* * *

HERE is a letter, picked from the hundreds that have come in—and are still coming in—from readers who have built the wonderful Four-Circuit Tuner. It is peculiarly significant because it comes from a self-confessed "hard-boiled ham" in New York.

"I have in the past used practically every circuit of any consequence, and almost every standard type of receiving apparatus. I am at present using a Reinartz, a super-regenerative and one of your justly famous DX hook-ups. For the last year I felt confident that we had reached the ultimate of selectivity and sensitivity in your DX receiver but since I have had the extreme pleasure of using the new Four-Circuit Tuner I have only realized what it is to receive broadcast as it should be received. Using two steps of amplification, *plus* a loud-speaker, the reception has been so perfect that it is beyond my limited vocabulary to do it justice.

"This morning, at about 1.30, through heavy static, I had the pleasure—with the accompanying thrill—to hear Chicago, Fort Worth and California. I had no trouble bringing in both Chicago and Fort Worth on a loud-speaker.

"I am not a rabid broadcast listener, but I must admit that the possession of one of your Four-Circuit Tuners will soften the heart of the most hardened ham to listen in for broadcast. I wish to thank you for the wonderful advancement you have made in radio communication."

—LEO JOHNSON

* * *

"THE man who discovered the electron," Sir Joseph J. Thomson (who is, naturally enough, one of the most distinguished of all living scientists), recently made a flying visit to the United States; during his stay he gave four talks on the electron before the Franklin Institute of Philadelphia. A coming issue of POPULAR RADIO will publish—for the benefit of such of its readers who could not attend the sessions—a contribution of Sir Joseph's that is based upon the first two of his talks.

* * *

IT was Sir Joseph, by the way, who was once approached by one of his assistants in the Cavendish laboratories who asked:

"Why is it, Sir Joseph, that scientists like yourself, who contribute so much to human progress, have such small incomes while people like manufacturers and retailers in London make so much money?"

"Ah!" Sir Joseph replied, "but think of all the dirty work they have to do!"

* * *

OF all the indoor sports indulged in by the students at Princeton University, bridge was voted the most popular and radio second.

How does Princeton explain the local vogue of bridge?

* * *

"I CONSIDER POPULAR RADIO the best magazine published," reports H. A. Goesly of New York. "Your hook-ups are the clearest that I have seen, and the list of instruments, with their capacities, which you publish in connection with the hook-ups, is a feature of great value to the fan."

* * *

WHEN POPULAR RADIO initiated the project last summer of broadcasting the outdoor concerts of the New York Philharmonic orchestra it established a vogue that has spread rapidly—to the great benefit not only of radio fans but also of musicians and music lovers as well. Since the successful experiment of last August the music of many great orchestras has been broadcast from many stations by means of the "pick-up" system.

* * *

IT is with particular gratification, therefore, we learn that the same project of broadcasting the concerts of the Philharmonic orchestra will be undertaken again this summer—and by the same station, WJZ.

(Continued on page 8)

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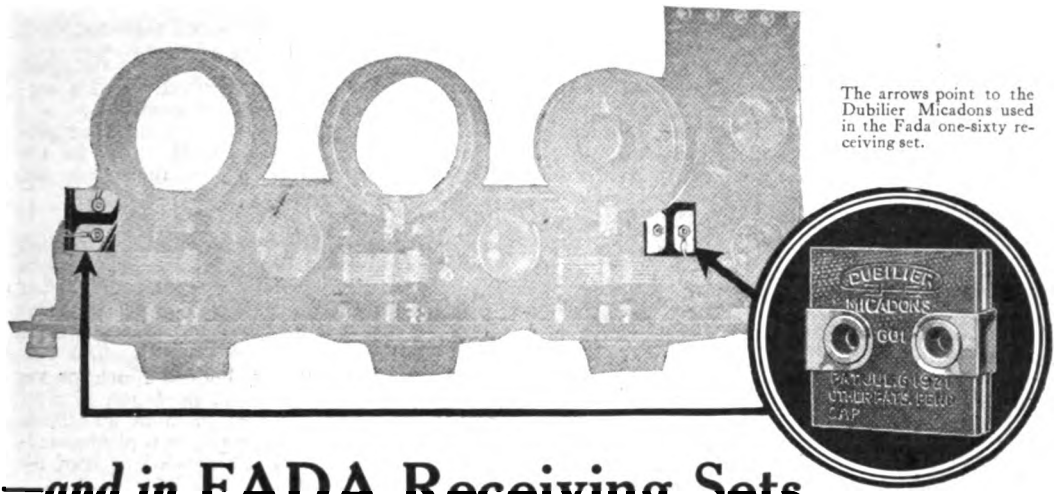

The arrows point to the Dubilier Micadons used in the Fada one-sixty receiving set.

—*and in* FADA Receiving Sets

DUBILIER Micadons are an essential element in the efficient Fada one-sixty Neutrodyne receiving set because they are the only fixed condensers made of standardized, permanent capacity.

In the Neutrodyne circuit everything depends on constancy of capacity. And the standardized and calibrated Dubilier Micadon condensers alone meet that requirement.

Dubilier Micadons are used in De Forest, Freed-Eisemann, FADA and other receiving sets made by well-known manufacturers with reputations to maintain.

If a set is not equipped with Dubilier Micadons the broadcasted radio program is not heard at its best.

Price 35 cents to $1.50. At all good dealers.

DUBILIER CONDENSER AND RADIO CORP.
48-50 WEST FOURTH ST., N. Y.

BRANCH OFFICES IN THE FOLLOWING CITIES:
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DUBILIER PRODUCTS

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PAGES WITH THE EDITOR

(Continued from page 6)

REPORTS about ourselves that reach us from sources that may rightly be regarded as prejudiced" either for or against us, may be just as rightly discounted. But here is a report about POPULAR RADIO that graciously comes to us from the publisher of a rival radio magazine—and even if it *does* emanate from an Esteemed Contemporary, the Editor just plumb refuses to discount it one iota. This report reads:

"You may be interested in knowing that the report turned in to me by a man whom I have just sent on a tour of some of the cities in what might be called the semi-rural district through middle eastern Pennsylvania show that POPULAR RADIO is growing in circulation faster than any other radio magazine and that his contacts with the advertisers also proved that their returns from your columns are better than those from any other magazine in the field.

"I am not at all surprised at this report because it was exactly what I thought myself." —HENRY M. NEELY

* * *

AGAIN our subscription manager intrudes upon the Editor's pages with the following announcement—which the subscription manager apparently wants our readers to get for their own interest:

> "We are constantly in receipt of requests for back copies of POPULAR RADIO. We now have a complete file beginning May, 1922. A single back number is $.17 *postpaid*, May, 1922 to January, 1923, inclusive; other issues are $.22 *postpaid*. All requests must be accompanied by remittance."

* * *

"I WAS very much enthused over your Four-Circuit Tuner as published in the May number. I believe that I am the first one to build the set in this city. The writer has read many radio magazines, but he has found none that is as full of facts or that can compete with POPULAR RADIO." —EDWARD J. MEISTER

* * *

SLOWLY but inevitably the fame of POPULAR RADIO is spreading abroad. In a single mail recently the Editor received a handful of letters from English fans—none of whom seem to be suffering from that "reserve" that has been regarded as so typically British. For instance:

"POPULAR RADIO is simply splendid!" enthuses Mr. T. L. Blake of Essex, England. "The articles are so wonderfully concise and explicit and the pictures, drawings and items are so clear and simple and understandable that they are truly a great help to the amateur."

* * *

WHILE from Mr. Frank Kennedy of Lancashire comes a report of his remarkable success with a single tube set that was described in POPULAR RADIO for April, 1923. He concludes with the enthusiastic comment:

"I want to congratulate you on your perfectly splendid magazine which is by far the best of all the American journals that find their way across to England."

* * *

AGAIN the Editor's holding files are crowded with manuscripts, diagrams and photographs that are of inestimable value to the radio fan everywhere. Most of this material describes new and improved receiving apparatus, recent inventions and discoveries of practical usefulness to the amateur, helpful hints for the assembling, installation and operation of radio equipment—all of it information of timely import that should be placed before our readers while it is still news and while it is of the greatest usefulness.

* * *

How can the Editor publish all of this new and valuable material—and keep on publishing new and valuable material as it becomes available—unless he adds materially to the number of pages in the magazine?

* * *

THE Editor believes that to enlarge the magazine is not only an obligation to our readers, but an inevitable development.

* * *

PLANS are now being worked out, therefore, for an important and significant announcement that will be made in our September number—an announcement that will be welcomed by all readers of POPULAR RADIO everywhere.

* * *

"THE article by Dr. Ernest Fox Nichols, *The Shortest Radio Waves Ever Produced by Man*, in your July number," a well-known scientist told the Editor, "is perhaps the most important contribution to the literature of radio since the announcement of the Hertzian waves in 1888. It is not only a real beat for POPULAR RADIO but an announcement of inestimable significance to science."

* * *

IT was Dr. Nichols, incidentally, who, while he was Professor of Physics at Dartmouth College some years, flunked the Editor—properly enough, too—in sophomore Physics I. It is with peculiar satisfaction, therefore, that the Editor heaps coals of fire on the good doctor's head and awards him a "perfect recitation" on his famous article!

Kendall Banning

Editor, POPULAR RADIO

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Kadel & Herbert

THE FOREMOST RADIO EXPERT OF FRANCE

The officer at the left is the famous General Gustave Ferrié, Inspector General of the Telegraph Service of the French Army, and one of the greatest authorities on radio in the world. An article by him will shortly be published in POPULAR RADIO.

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Brown Bros.

Lightning Has No Terrors for a Loop Antenna

Even during the most violent electrical storms the reception of broadcasting on a loop aerial is not greatly affected. And broadcasting may often be received on an outdoor antenna right up to the time that the storm hits the vicinity. The troubles due to "static" have been grossly exaggerated—as every experienced radio fan knows.

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Popular Radio

VOLUME IV AUGUST, 1923 NUMBER 2

THE WINNING FIGHT *against* STATIC

How Science Is Eliminating the Interference from "Strays"

This article has been written by one of the world's foremost authorities on radio. It has been written for the express purpose of dispelling some of the foolish illusions held by the more inexperienced radio fans concerning static—a subject that is becoming of less and less importance in radio work as science is slowly and surely devising means for overcoming it. Our "fear" of static diminishes as our knowledge of it increases. Read this article—and bury the static bugaboo once and for all!—EDITOR.

By JOHN V. L. HOGAN

ATMOSPHERIC interference with signal reception has always been the *bête noir* of radio from the earliest days of the practical art.

This interference goes by a number of names, "X's," "strays," "atmospherics," "static," and so on; perhaps more attention has been given to reducing its harmful effects than to any other single problem of radio engineering.

What is the net result of all this effort? Has the long-fought battle against the natural enemy of radio been at all effective? Has interference from strays been eliminated, and if not, why not? These are questions worth thinking about.

The simple fact is that stray trouble has been so greatly reduced that radio stations are today working over great distances by the use of smaller transmitting power than would have been thought possible ten or even five years ago. The art of atmospheric interference reduction has progressed tremendously in the past decade.

Why, then, do we still hear of long-distance reception being interrupted by "static"?

The simple answer to that question is that while the radio engineers have been devising successful methods of reducing stray interference, they have also been producing new and marvelously sensitive radio receivers. These delicate instruments respond not only to exceedingly weak signals, but also to the much reduced stray waves that penetrate our best systems for minimizing atmospheric interference.

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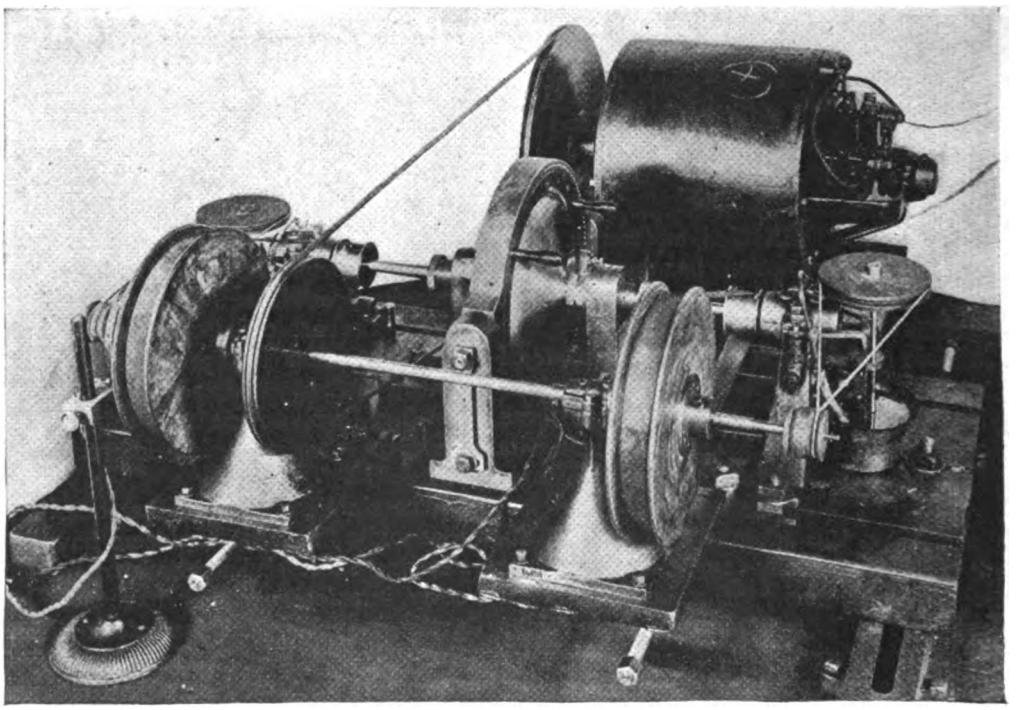
The radio art has reached the point where strays need not interrupt commercial communication services, except possibly during occasional short periods of extreme interference. A few years ago there was no commercial or other radio service that was free from frequent and extended serious interruption by strays. The summer, in these latitudes, was once a time when radio messages were received more by good luck than by good engineering; but matters are very different today.

Two Kinds of Atmospherics

Let us first consider, for a moment, what this atmospheric interference is and what effects it produces.

To begin with, there are at least two classes of "atmospherics." The word "static" is popularly used to cover all sorts of naturally produced interference, but properly speaking it should be limited to the electric charges that are carried to a receiving aerial by particles such as dust, snow or moisture in the air. These particles, whether of smoke, steam or merely the motes that one sees in a beam of strong sunlight, are usually electrically charged. When they strike an antenna they transfer their charges to it. If the antenna is connected to a receiver, the charges will ordinarily pass silently to earth without producing any sounds in the telephones.

Series condensers in the antenna circuit of some receivers prevent this quiet discharge from the antenna to ground, and the charges pile up on the plates of the condenser. When the voltages so produced are not large (as is usually the case with small receiving antennas)



AN EARLY GUN IN THE FIGHT AGAINST STATIC

The first high frequency alternator to be developed as a method for producing the first C.W. signals. When it was used with a heterodyne receiver (such as illustrated in the photograph on page 94) it was found to be a reliable means of communication. It produced a high shrill note in the receivers which was easily distinguishable from the rasping noises of even heavy static.

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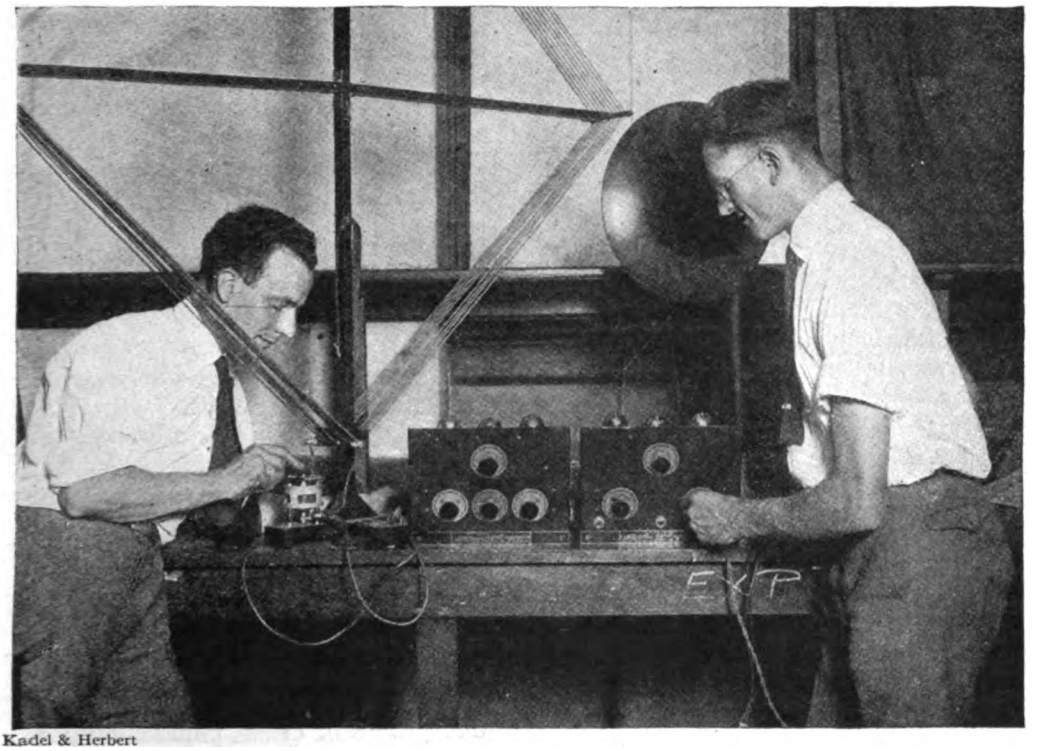

Kadel & Herbert

ONE OF THE BEST METHODS OF AVOIDING INTERFERENCE

Use a loop antenna and radio frequency amplification, not because radio frequency amplification itself reduces static, but because the loop increases the signal-stray ratio of your receiver, although but a small amount of signal strength is received. The radio frequency amplifier, however, plays its part in bringing up the signal strength of the signal that is received with the loop, without the accompanying disturbance from strays.

nothing happens to interfere with reception. However, if a large antenna is used the voltage may build up to a value high enough to cause sparking across the condenser at intervals of every few seconds, or even more frequently. For each spark across the condenser one hears a loud "bang" in the telephones.

There are four remedies for this condition (which is rarely encountered in broadcast reception):

First, use a condenser which is so well insulated that it cannot spark across;

Second, reduce the size of the antenna;

Third, connect a grid-leak of about ¼ megohm resistance across the condenser to keep it discharged;

Fourth, use an antenna circuit that will tune *without* a series condenser.

Any one of these plans will eliminate this kind of static interference whenever it occurs.

Another effect produced by true "static" or the contact-charging variety of atmospheric interference, is a slight hissing noise heard in the receiver when heterodyne or oscillating beat-note reception is used. Ordinarily this hiss is so weak as not to interfere with telegraphic receiving, and it is entirely absent in the majority of radio telephone receivers.

Both of these interfering effects of true "static" can be completely avoided by using indoor antennas or coil antennas, or even by the use of outdoor antenna systems that have no ground connection.

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"Stray Waves" and "Grinders"

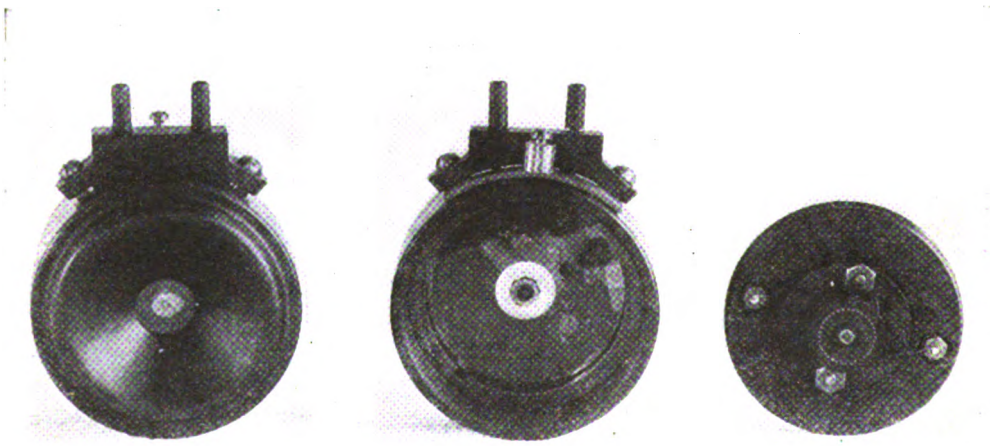
The other class of atmospheric disturbance is the one that causes the most trouble; such troublesome impulses are properly called "strays."

There are at least two kinds of strays, each named by the sound it produces in the receiving telephones. The first kind, named "clicks," as a general rule gives less trouble than the second kind, which is called "grinders."

The clicks may sometimes be of rather great intensity, but they are usually separated by "quiet" intervals and so do not constitute serious interruptions unless they are so severe as to paralyze (for an instant) either the receiving apparatus or the operator's ears. It is often easy to identify a strong stray click with a distant but visible lightning discharge that is seen *at the same instant the click is heard*. This supports the theory that clicking strays arise directly from electrical storms near the earth's surface. Clicks are frequently heard during the stormy seasons even on clear days, but they are then much weaker than when a thunderstorm is passing near by. The probability is that the stray electromagnetic waves generated by an intense lightning stroke travel outward in all directions for hundreds of miles, just as do the electromagnetic signal waves produced by a radio transmitter.

The second kind of strays, called grinders, are usually more disconcerting. A coffee-mill turned more or less continuously and at varying speeds is not a desirable accompaniment for either music or conversation, and intense grinder-type strays usually are just about as much of a disturbance. If some one, intent on bothering us, started to grind coffee in the living room, we should try to put him out or to curtail his activities. We *cannot* stop grinder strays at their source, however, for we don't know exactly what produces them or whence they come.

There is some ground for the belief that grinders are nothing more than irregular groups of clicks, piling one upon another in helter-skelter fashion and producing the characteristic more or less



ONE OF THE FIRST "STATIC ELIMINATORS"

The earliest type of heterodyne telephones. This earpiece was used as a sort of combination detector and telephone; it contained a fixed coil through which circulated a current of slightly different frequency than the signal frequency which was lead through a moving coil attached to the diaphragm. The corresponding beat frequency which occurred between the two currents was used to actuate the diaphragm; it produced a high whistle which was easily read through static.

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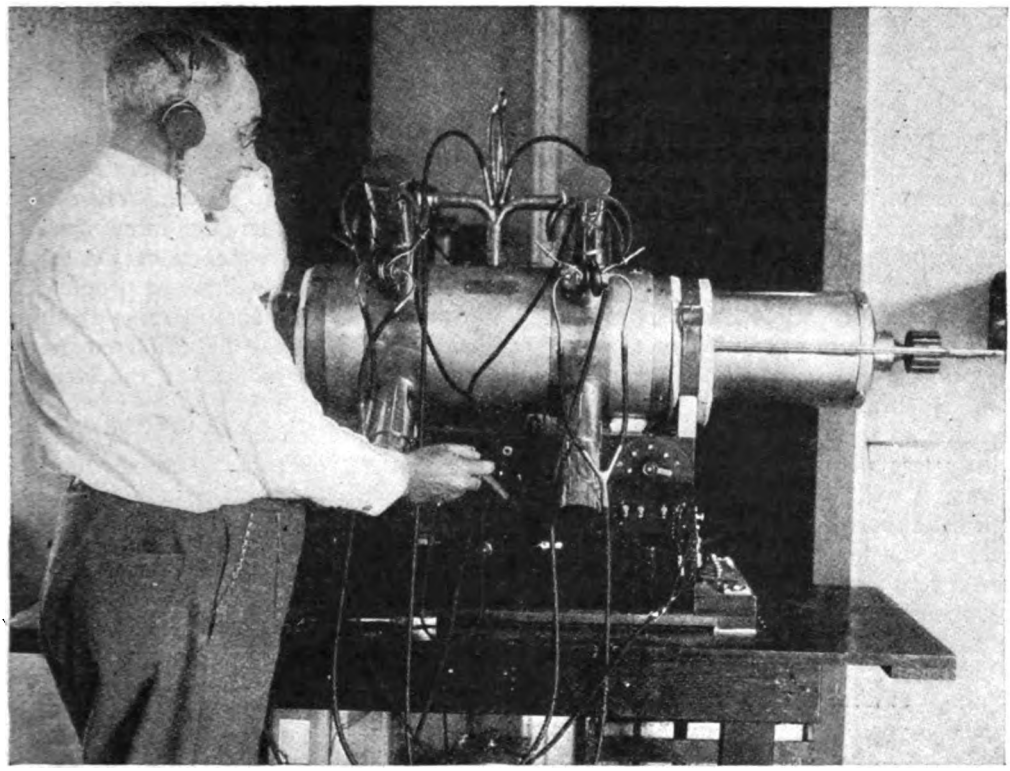

Pacific & Atlantic

A MODERN SPECIMEN OF ARTILLERY
DEVISED TO ATTACK "STRAYS"

This is one of the innumerable developments which come under the heading of "static eliminators." The device pictured above is the invention of W. J. Scott. It is being tested by the Navy Department at Washington.

continuous rattling and grinding sounds. There is also some experimental evidence to indicate that grinders usually arrive at our receiving stations from high altitudes, while clicks seem to come along the surface of the earth. However, no matter where either of them really do come from, it is certain that both reach our receiving antennas as abrupt and irregular electromagnetic waves that have many characteristics identical with the waves which carry radio signals. It is this approximate identity between stray waves and signal waves that has made it so hard to devise apparatus which is able to distinguish between them.

So much for our short summary of what static and strays are. Let us now think for a moment about the effects that stray waves produce when they strike a receiving antenna system.

What Strays Do to Your Antenna

We know that radiant electromagnetic waves (in space) consist of electrostatic and electromagnetic forces that vibrate at certain frequencies and with certain intensities, and that increase or die away in accordance with certain power variations of the generating system. We know that these waves spread out in all directions from the point of origin traveling away from this central point with the speed of light—186 miles in each one-thousandth of a second. We know that whenever the wave-forces strike a conductor such as a receiving antenna wire they try to produce currents in that wire, and that by tuning

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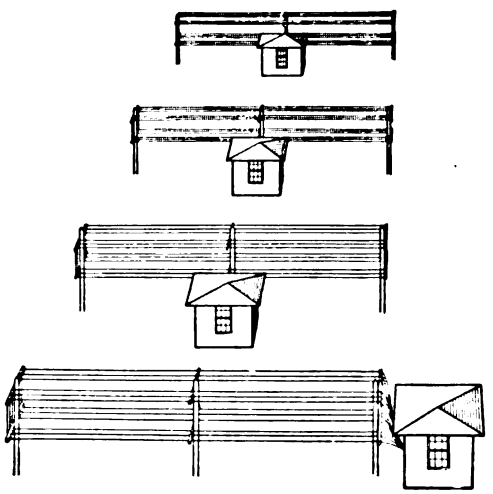
the receiving antenna system we can greatly increase the currents that will be set up in it by the arriving waves. We must make the natural frequency of the tuned receiving antenna circuit the same as the frequency of the waves we desire to intercept, if we are to have produced in it the greatest possible amount of current or power.

You can perhaps grasp the latter part of this idea, more clearly, by imagining a pendulum consisting of a weight suspended on a three-foot length of wire. Such a pendulum will swing from one side to the other and back again in a little less than two seconds. That is to say, it will have a natural frequency of a little more than thirty cycles a minute. If you take hold of the suspending wire a few inches from the top, you will find it difficult to make the weight swing unless you push and pull the wire at the natural frequency of about thirty per minute. On the other hand, if you do drive the pendulum at its natural rate of oscillation you will be able to build up a greater swinging of the hanging weight by little more than a slight push on the wire applied at the proper instants.



AN ELABORATE ANTENNA SYSTEM FOR STUDYING STATIC

A schematic diagram of one of Dr. G. W. Pickard's early systems for reception during the static periods. This system was for use on long wavelengths.

The pendulum is a tuned *mechanical* system; the ordinary receiving aerial is a tuned *electrical* system.

Your hand in swinging the pendulum by regular impulses is a periodic driving force; so is a radio wave. When the frequency of the driving force agrees with the natural frequency of the pendulum, the largest swings are produced. So, when the frequency of the driving wave agrees with the natural frequency of the radio antenna system, the largest currents are produced.

Now for the effect of a stray wave. Suppose that you shot a revolver at the hanging weight, what would happen? The bullet would strike the weight and force it a certain distance to one side, and then the pendulum would commence to swing back and forth at its natural frequency, the swings gradually dying away. The larger the energy of the bullet, or the smaller the size of the hanging weight, the larger would be the swing of the pendulum before it commenced to die down.

In much the same way, when a stray wave strikes a receiving aerial it produces in it electric currents of the antenna system's natural frequency, and these currents gradually die away to nothing. The larger the energy of the stray wave, or the smaller the *persistence* of the antenna system, the larger will be the current before it commences to die down.

How to Distinguish Between Strays and Signals

If we bear in mind that the hand-swung motions of the pendulum correspond to radio signal currents in the antenna, whereas the shock excited, dying-away motions correspond to the undesired stray wave currents, we can see at once some of the difficulties that lie in the way of distinguishing one from the other. Once we let stray waves produce currents in our antenna systems, about the only differences we can

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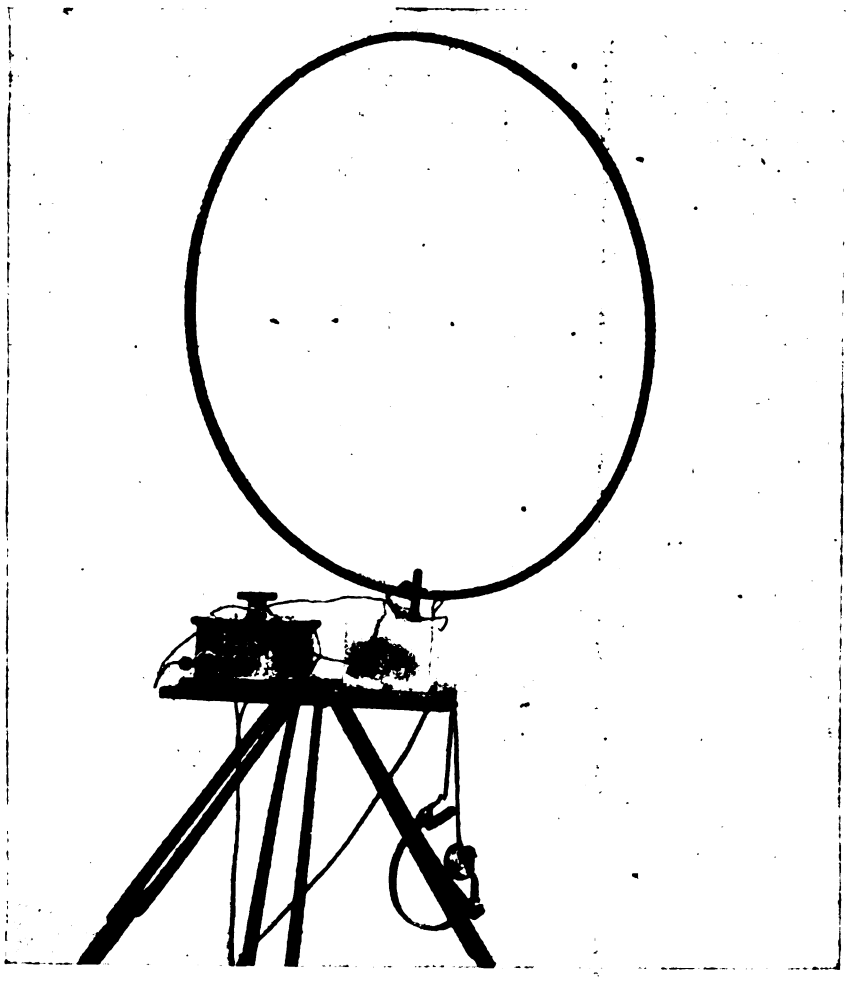

AN ANCESTOR OF THE LOOP ANTENNA

The first portable radio compass used in 1907 and 1908. It is with a development of this loop that many facts have been found out about static and its causes and effects. It has been used to determine the directional effects of static and much valuable and important data has been gathered by its aid.

detect between the unwanted stray currents and the desired signal currents is, that the latter may be uniform and regular whereas the former are always of the *damped* or dying-away variety and are always erratic and irregular.

Thus the problem of reducing interference from strays falls into two parts. The first is to keep stray waves from affecting the antenna system, and the second is to discriminate between signals and strays once they have both produced radio frequency currents in the antenna wires. Substantial progress has been made in both divisions of the attack; and the advances have been cumulative and continuous for the past ten years or more.

It should be clear that we are not particularly interested in the *absolute* elimination of stray interference, except possibly as a theoretical ideal. So long as this kind of interference can be kept as small as or smaller than other unavoidable kinds of interference, we are satisfied. The easiest and best way to

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measure the effectiveness of any scheme for reducing the harmful effects of strays is to study the ratio of signal intensity to stray intensity under various conditions for a long period of time. If the signal-stray ratio can be kept reasonably high for practical working, the scheme is a good one.

The Signal-Stray Ratio

Obviously the signal-stray ratio of any receiver varies from moment to moment even when listening continuously to some particular transmitter. Let us imagine that during some evening you are receiving from a broadcast station that is heard with an intensity of 200 (on an audibility meter), and that in the course of the evening the average stray intensity swings up and down irregularly between 20 and 400. Clearly enough, this means that the signal-stray ratio will be varying irregularly from 200/20, or 10, down to 200/400 or ½. If you had instead been listening to a nearer station that was heard with an intensity of 600, the signal-stray ratio would have varied between 30 and 1.5. This means, of course, that at the worst moments the signals would have been 1½ times as loud as the strays.

On the other hand, if you had been trying to receive from a far distant station that gave an intensity of only 40, the best ratio would have been only 2 and the worst 0.1—the strays ten times as loud as the signals.

Now consider that the signal intensity corresponds to the force with which you are keeping the pendulum swinging, whereas the stray intensity is analogous to the force exerted by the bullet that strikes the pendulum weight. Clearly enough, to keep the pendulum going regularly you need strong driving forces, and a large weight compared to the weight of the interfering bullet. Similarly, to receive messages regularly you should have strong incoming signals, and circuits not easily disturbed by the abrupt stray waves.

How to Reduce the Effects of Strays

What can we do to a radio circuit that will make it less subject to strays?

Merely increase its natural persistence of oscillation—which is another way of saying increase its inductance and reduce its capacitance and resistance. By using shorter antenna wires and adding low-resistance inductance coils to tune to the desired wave frequencies, or by putting a small series condenser (say of 0.00025 microfarad) in series with a larger antenna the persistence of the circuit can be substantially increased. Similarly, loop or coil antennas are generally much more persistent than ordinary antennas, hence are less subject to stray interference.

Of course, cutting down the size of your antenna is likely to weaken the signals you will receive from any particular station; the point is, however, that the stray interference will be weakened *still more,* or in greater proportion, and thus the signal-stray ratio will be improved. The numerical value of signal strength may be then regained by additional amplification, without bringing the strays up to their former intensity.

As an example of this, suppose that changing over from the plain antenna to the coil antenna brought the signal intensity above given as 200 down to 100, but at the same time reduced the stray intensity from between 20 and 400 down to between 2 and 40. Then the signal-stray ratio instead of varying between 10 and ½ would lay between 50 and 2 5, and the signals would always be at least 2½ times as loud as the strays instead of occasionally being only one-half as loud. A two-fold additional amplification would bring the signals back to the original intensity of 200, while preserving them much louder than the strays.

There are various and more elaborate ways of improving the signal-stray ratio of receivers, but although these rather complicated arrangements are of definite

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value for radio communication using low wave-frequencies (long waves) they are not necessary for amateurs or broadcast listeners. The waves that have been set aside for amateur and broadcast transmission are largely free from the severe stray interference that is found at the wave frequencies used for long distance radio telegraphy. This fortunate state of affairs leaves matters so that radio broadcasting over reasonable distances is seldom interfered with seriously except when thunderstorms are nearby. By careful antenna design and the use of efficient amplifying circuits, and with skillful adjustment so as to keep the signal-stray ratio high, successful reception may even be carried on in the midst of local storms and reasonably long distance receiving is not tremendously handicapped by the customary quantity of summer-time short-wave stray interference.

The Regularity of Signals and the Irregularity of Strays

There remains for us to consider only the question of distinguishing between stray effects and signals, once the currents have been set up in the receiving system. The most useful plans for such discrimination are based upon the regularity of signals as contrasted against the irregularity of stray disturbances. The pure continuous wave used in radio telegraphy is exceedingly valuable in this respect, for its uniformity and persistence permit the use of highly selective circuits and loose couplings that tend to suppress strays in a way that is not attainable when spark or damped-wave transmission is utilized. With spark radio telegraphy about the best that can be done is to produce the wave-trains at a high and definitely regular audio frequency, so that the dots and dashes are heard as high-pitched, pure musical tones which sound very different from the clicks and grindings of the stray waves. With continuous waves, radio-telegraphic reception is best car-

Signal Corps, U. S. A.

A HIGHLY EFFICIENT LOOP

The use of the modern long-wave loop is one of the chief factors in obtaining unlimited and uninterrupted radio communication service in our military departments. Above is seen one of these loops used for long-wave reception by the Signal Corps of the army at Washington, D. C.

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ried on by the heterodyne method, in the customary applications of which the desired signals not only are heard as high, pure musical tones but also are amplified in a selective fashion that does not magnify the stray-wave currents to the same extent.

Radio-telephone listeners are greatly aided in distinguishing speech and music from stray disturbances by the fact that the human ear has through many generations evolved into a wonderfully effective mechanism for sorting out and discarding irregular noises. Just as we can converse without great difficulty amid noises that would almost drown out the clicking of a telegraph sounder, so we can receive and understand radio telephone signals in spite of interference that would render dots and dashes unintelligible.

There have been produced various forms of acoustic and electrical filters for taking advantage of the difference in regularity between strays and *telegraphic* signals, and some of these are very useful. Indeed, it is possible to aid even telephonic reception to some degree in this way, but as a rule such refinements are not essential in local broadcast work.

One last word as to irregular noises! *Don't* think that all the clicks and rattles heard in some radio receivers are caused by strays. Many times interference blamed on "static" is really produced by *noisy tubes or batteries,* and may be completely eliminated by a few judicious replacements.

Don't get the idea that summer-time static can prevent useful radio work. Remember that golf played on links like a billiard table would be no sport at all; the hazards make the game.

Use your ingenuity and skill to build up the signal-stray ratio of your receiver, and you will *never* have to complain that stray-wave troubles have made radio less interesting.

Travelette Photo News

A RECEIVER WITH A TIN LIZZIE ATTACHMENT

Here is one of the rapidly growing army of radio fans who carries his radio set along with him on his vacation jaunts. In this case the apparatus is such a prominent part of the Ford car that it has become, in effect, a radio set on wheels.

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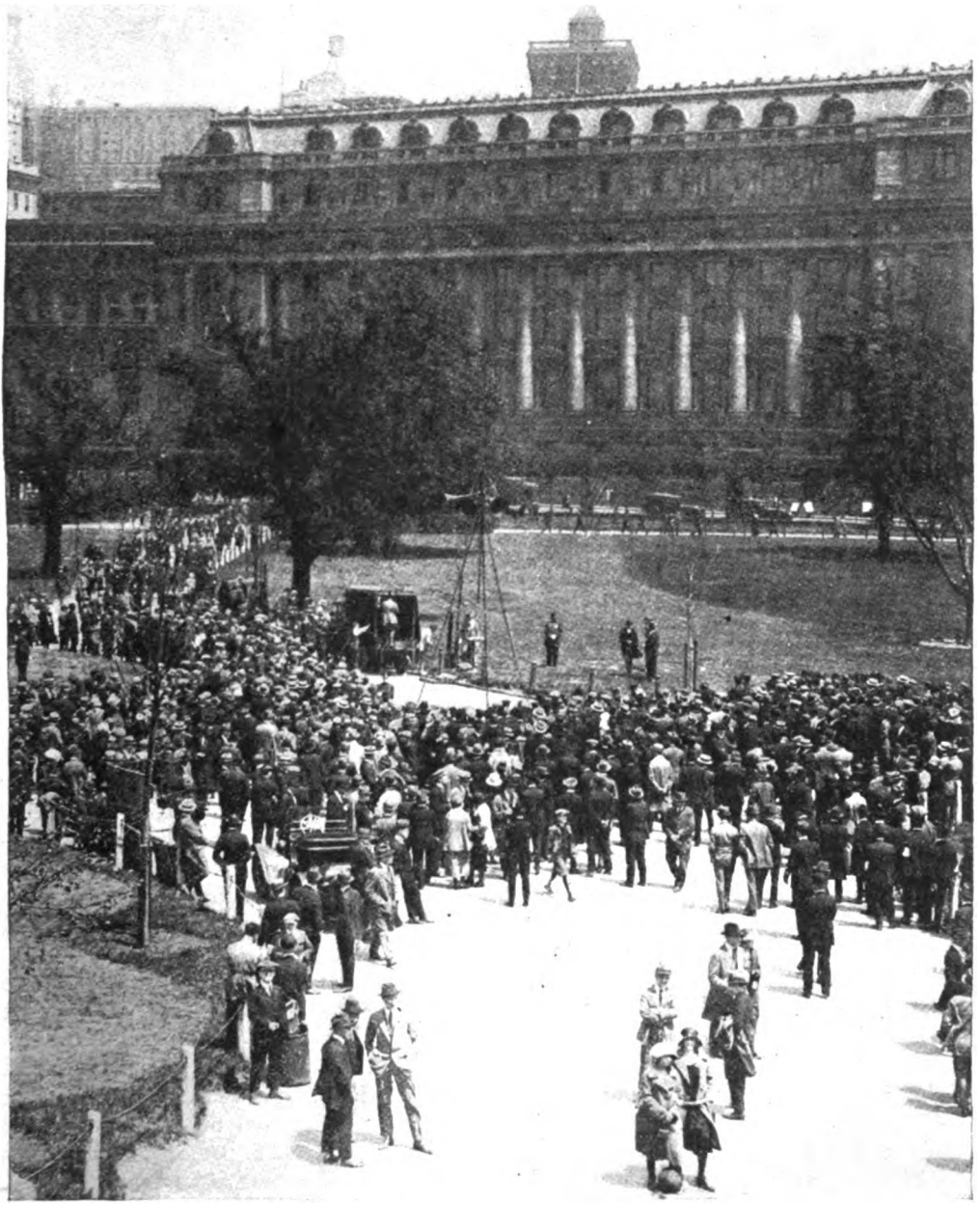

International

"Their Master's Voice"

As a demonstration of what may be done—and of what inevitably will be done—for reaching great masses of people by radio, this portable receiving apparatus, equipped with powerful loudspeakers, was recently set up in Battery Park, New York, during lunch hour. How many people could be reached by the President's voice if similar apparatus were operated in every city and town in the country?

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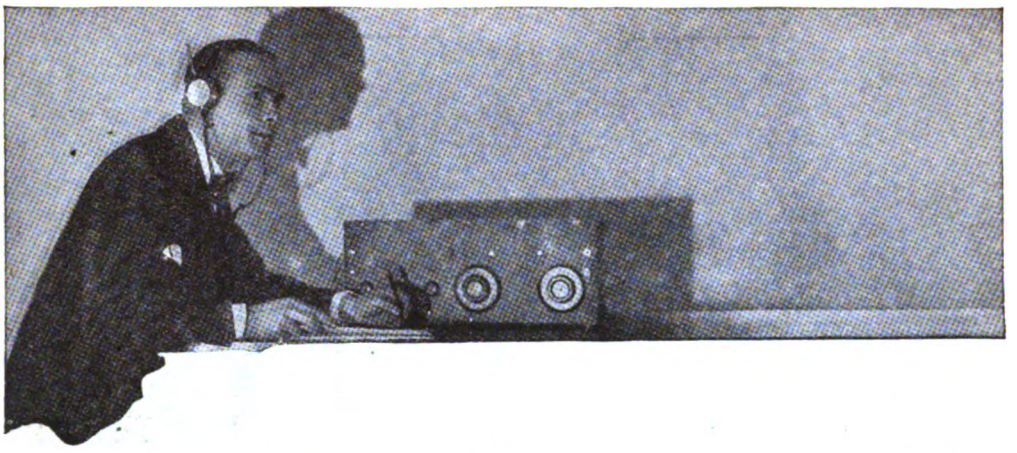

"Thou Shalt Not Broadcast—"

CERTAIN COPYRIGHTED MATERIAL HEREINAFTER SPECIFIED

THE American Society of Composers, Authors and Publishers is demanding fees from radio stations for broadcasting copyright material owned by its members. Some broadcasting stations may pay it; others are refusing on the ground that the Society includes only a portion of the composers. And the producing managers of musical comedies are also presenting their claims to both the Society and to the composers! How the law interprets these at present complicated rights is outlined in this article by an attorney who has made a special study of this subject.

By CHARLES H. KESLER

IF a broadcasting station wanted to broadcast a copyrighted, non-dramatic book it could do so. The copyright laws do not cover this method of presenting a book. One could indeed hire a hall, charge an admission fee and read a copyrighted book to the audience without any liability.

But who would want to go?

It is questioned if the broadcasting of books by radio, other than tales for children, be desired by the radio public.

There are, however, certain forms of writing or copyrighted matter which may be infringed if broadcasted by radio. Among such writings are lectures, sermons and addresses, dramatic and dramatico-musical compositions and musical compositions. In fact the American Society of Composers, Authors and Publishers, an organization granting licenses for the public delivery of copyrighted songs, intends to charge fees ranging from $250 to $5,000 to radio stations for broadcasting its songs and musical selections.

This society has been formed for the purpose of granting licenses to persons who desire to render copyrighted musical selections in public. It is a lawful organization and a practical one, as it is apparent how difficult it would be for an artist or other person or company to secure licenses from each owner, author or composer individually, considering their great number and also the number of copyrighted songs there are. Of course a license from the Society of Authors and Composers gives no one the right to render copyrighted

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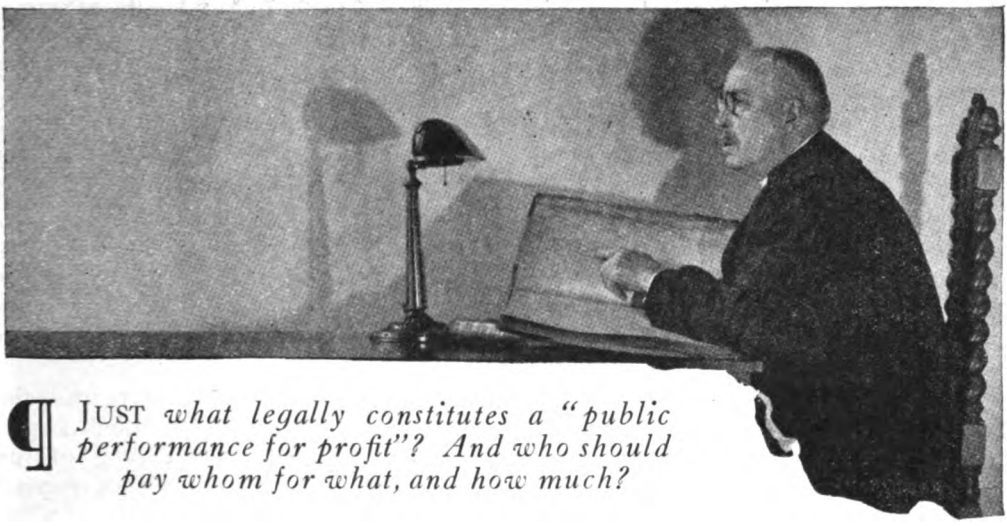

¶ JUST *what legally constitutes a "public performance for profit"? And who should pay whom for what, and how much?*

songs owned by persons who are not members of this society.

It was not until 1909 that the copyright law conferred upon an author or owner of a copyright, the exclusive right "to perform or represent the copyrighted work publicly for profit if it be a musical composition," although there was then in force, and still is, a criminal statute prohibiting such performances.

The present law also confers upon the person entitled thereto the exclusive right "to deliver or authorize the delivery of the copyrighted work in public for profit if it be a lecture, sermon, address or similar production."

The author or owner has the exclusive right to perform a drama (or dramatico-musical composition) publicly, whether for profit or not.

The copyright laws and the courts recognize two classes of musical selections; "dramatico-musical compositions" so called, and just plain "musical compositions."

The first class includes musical comedies, musical shows, operas and productions of similar nature.

The selections listed under the second class are published as single songs or musical selections, and are such as are not copyrighted as parts of a dramatic work. The copyright on a musical dramatic production covers also any copyrightable component part of it and this part, if republished as sheet music with a suitable notice of the original copyright, should still retain all rights acquired as a copyrighted dramatico-musical composition.

The owner of a copyrighted drama (or "dramatico-musical composition") has the exclusive right "to exhibit, perform, represent, produce or reproduce it in any manner or by any method whatsoever," whether for profit or not.

It should be noticed that the language of the Act here is very broad—sufficiently broad, in fact, to give the copyright owner the exclusive right as to public performances "in any manner or by any method whatsoever," such as by moving pictures, phonographs, radio broadcasting or even where radio receiving is done publicly. This language is also sufficiently broad to cover moving picture films, phonograph records or music rolls of dramas or musical selections taken from the copyrighted dramatico-musical composition.

The reader, therefore, should bear in mind the distinction between mere "musical compositions," in which the element of "profit" must be present in the case of a public performance, and

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technical "dramatico-musical compositions" which cannot be performed publicly even though not for profit.

Another right conferred by the copyright laws is the exclusive one "to make any arrangement or setting of a 'musical composition' or of the melody of it in any system of notation or any form of record in which the thought of an author may be recorded and from which it may be read or reproduced. . . ."

The clause quoted relates to phonograph records and music rolls. The payment of royalty on each record or roll made frees the record or roll from further contribution to the copyright except in case of public performance for profit. "The reproduction or rendition of a musical composition by or upon coin-operated machines shall not be deemed a public performance for profit unless a fee is charged for admission to the place where such reproduction or rendition occurs."

What then is meant by "public performance for profit"?

The Supreme Court of the United States answered this question in two cases considered at the same time: Victor Herbert *vs.* Shanley Company, and John Church Company *vs.* Hilliard Hotel Company (Vanderbilt Hotel).

Although the copyrighted music considered was taken from musical shows the facts peculiar to the two cases made it necessary for the Court to pass on the question of profit.

In the first case Herbert was the owner of a comic opera entitled *Sweethearts* which contained a song of the same title. This the Shanley Company caused to be sung by professional singers accompanied by an orchestra upon a stage in its restaurant on Broadway.

In the second case the Church Company owned the copyright of a lyric comedy in which is a march called *From Maine to Georgia.* The Hilliard Company caused this march to be per-

Westinghouse

A CONCERT THAT RAISES A DELICATE LEGAL PROBLEM

When Uncle Sam issues a copyright on a musical composition and an officer of Uncle Sam's Army orders a military band to play it in a broadcasting station, what can the composer do about it—in face of the fact that he cannot sue the government?

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Westinghouse

THE MAKERS OF THIS PIANO-PLAYER ALSO OWN THE COPYRIGHT ON SOME OF ITS MUSIC

The law permits only those who own the copyright to make use of it. When a reproducing piano-player concern buys a copyright from a composer, therefore, it can broadcast the music at will.

formed in the dining room of the Vanderbilt Hotel for the entertainment of its guests, during mealtime, by an orchestra employed and paid by the Hotel Company.

These two cases present the question whether the performance of a copyrighted musical composition in a restaurant or hotel without charge for admission to hear it infringes the exclusive right of the owner to perform the work publicly for profit. Although it is easy to get in, as is well known to those of us who fortunately or unfortunately, have dined at Shanleys or at the Vanderbilt, it is not so easy to get out. The piper has to be paid.

Mr. Justice Holmes delivered the opinion of the Court in language worthy of the son of the *Autocrat of the Breakfast Table.* Justice Holmes said:

"If the rights under the copyright are infringed only by performance where money is taken at the door, they are very imperfectly protected. . . . . The defendant's performances are not eleemosynary. They are part of a total for which the public pays, and the fact that the price of the whole is distributed to a particular item which those present are expected to order is not important. It is true the music is not the sole object, but neither is the food, which probably could be got cheaper elsewhere. . . . . If music did not pay, it would be given up. If it pays it pays out of the public's pocket. Whether it pays or not, the purpose of employing it is profit, and that is enough."

According to this decision even the playing of a copyrighted "musical composition" in a restaurant by means of a phonograph or player piano would be considered an infringement, except if the instrument were coin-operated. The similar playing of a "dramatico-musical composition" would, of course, be an

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infringement even though the purpose was not profit.

It is an erroneous impression which some have that, if they purchase an authorized sheet or a record or a music roll of a copyrighted song, they can use it to perform or render the song publicly. No right to so publicly perform it is implied by the purchase, except where the music purchased is a "musical composition" and the performance is not for profit, directly or indirectly, also excepting coin-operated devices.

The unauthorized broadcasting of "dramatico-musical compositions" is an infringement even in cases where the purpose is not profit. This means that neither schools, colleges, charitable institutions nor amateurs can broadcast such selections without license, not to mention radio manufacturers.

The language of the Act relating to such "dramatico-musical compositions" is very broad. There are no exceptions, no limitations circumscribing the exclusive right granted to the copyright owner when the selection is a dramatic musical composition.

When referring to mere "musical composition," however, the language of the statute is not as broad. The anti-limitation "in any manner or by any method whatsoever" is conspicuous by its absence. This seems to imply that the granted right to perform the mere "musical compositions" publicly has limits other than that as to profit. That is, the Act cannot be stretched beyond its elastic limits to cover all kinds of performances. This is a point for the defense. Whether or not the courts will draw the line more sharply between a musical selection which fortunately originated in a musical comedy and a similar selection which is a free lance, so to speak, remains to be seen. The broadcasting situation has clearly raised this issue. As far as broadcasting is concerned, the difference between one class of selections and the other, is the difference between twelve and a dozen, merely logical. It is true their origins are different and they are made different by law.

But is the court going to say that one copyrighted song can be broadcast without infringing and another cannot?

Were such distinction made, it would be necessary for the copyright owner clearly to indicate or give notice that the piece or selection is covered as a dramatico-musical composition. If the court refuses to draw the line it will hold that even copyrighted "musical compositions" are infringed when broadcast for profit.

There remains, however, that doubt as to whether or not "musical compositions," as distinguished from "dramatico-musical compositions," can be broadcast for profit without infringement. Looking at it in what I do not hesitate to say is a reasonable manner, one should say, "certainly, broadcasting is a public performance." Yet we should consider and understand that courts are apt to look at such strictly statutory rights in a very technical manner, construing them narrowly, on the principle enunciated by the gentleman from the state just west of the Mississippi. It is not a cut and dried case for the copyright owner. The defense can offer argument the other way. It is a point the court might decide either way.

POPULAR RADIO for August, 1922, referred to the case of White-Smith Music Publishing Company *vs.* Apollo Company, in which the Supreme Court of the United States ruled under the old law that perforated music rolls which, when used with piano players to reproduce copyrighted musical compositions, do not infringe the copyright. The court held that the sale of such rolls (or records) was not a printing, publishing or copying of the copyrighted work within the meaning of the old Act. The copyright laws were strictly construed by the court. After that decision the laws were amended to give

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Westinghouse

AN AUTHOR DOES NOT NECESSARILY OWN THE RIGHTS TO HIS OWN WORKS

When Ralph Mayhew reads from his own "Bubble Books" and broadcasts the gramaphone records of his own songs he can do so only with the permission of his publishers—who own the copyright.

the copyright owner the exclusive right as to records and music rolls also.

Similarly radio broadcasting is a new situation developed since 1909 when the present copyright laws went into effect although radio and telephoning were known at that time. Without giving the clause "to perform the copyrighted work (a musical composition) publicly for profit," a strained construction, just what does it mean? Can it be construed to cover a situation other than that of an artist in personal touch with his or her audience like the Vanderbilt and Shanley cases? The playing of a copyrighted musical composition on a phonograph or player piano is considered a "performance" if done publicly for profit. But is such a performance done "publicly" unless the audience is actually present to hear and see the phonograph or artist? Must not there be a place for the public to be other than in their homes?

Congress couldn't have had radio broadcasting in mind when it framed the copyright Act of 1909. Broadcasting as we know it was unknown then. It did, however, secure for the author of a "musical composition" the exclusive right as to instruments like the phonograph or player piano. This was intended. But any public performance had to be for profit. It is true that unqualified rights are given the author of a dramatic work but it is doubtful (although I have not studied the congressional proceedings) if Congress really intended that an author should have unlimited rights as to the public performance of a song merely because it was taken from a dramatic work. I believe it was the intent of Congress to place all songs as to public performance on an equal footing, the test to be whether or not the performance was for profit. In the endeavor to give the author of a dramatic work all

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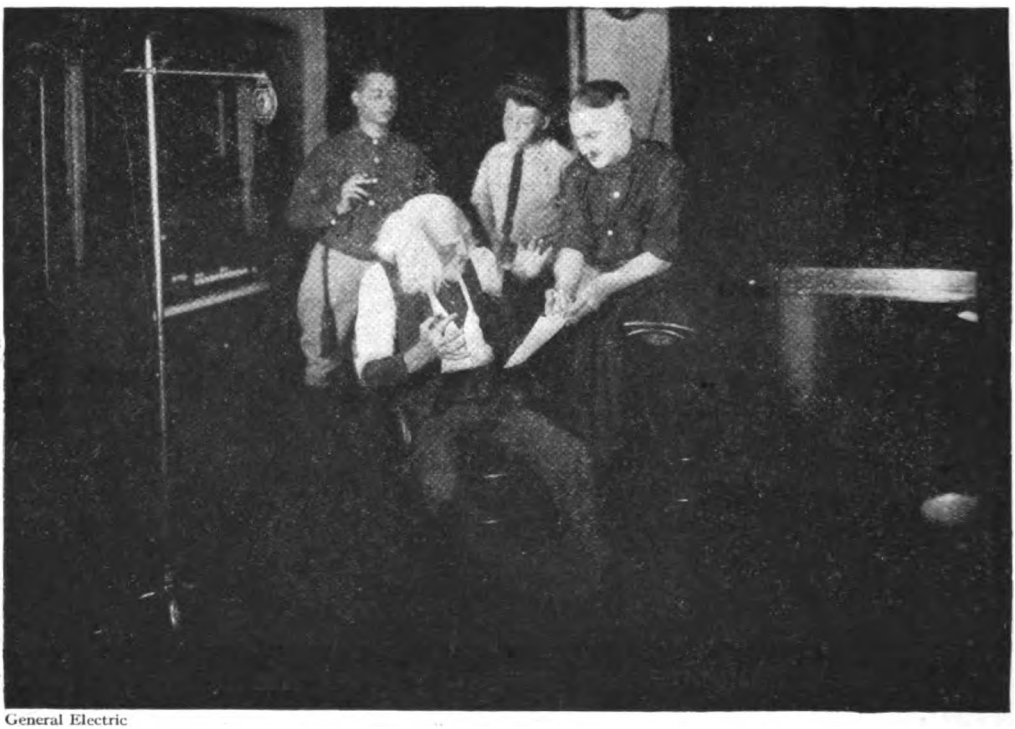

General Electric

A "PUBLIC PERFORMANCE FOR PROFIT" OF A DRAMA

Only the owner of a copyrighted play can legally authorize its presentation "whether for profit or not." (Question: Why do the actors who are broadcasting the scene illustrated above don their costumes and make-up?)

rights of performance, Congress apparently overlooked the fact that songs *without* dramatic action could be rendered separately from the dramatic work of which they formed a part. Granting that might have been the intent of Congress, nevertheless the law relating to dramatic works as it now stands does not express such intent. The law on the contrary is very broad. It covers all kinds of performances by all possible methods.

The point I wish to make, however, is that a Court might very well rule that radio broadcasting of "musical compositions" is not a public performance as commonly understood or within the meaning of the Act. If Congress had intended to include the public performance of musical compositions for profit "in any manner or by any method whatsoever" it would have so worded the law as it did in the case of dramatico work. But it didn't do it. Congress did take pains to include record-operated machines. But can the Act be stretched to include this different way of rendering musical compositions—with radio apparatus? If under the old law a record or music roll was not considered a print or copy of a copyrighted musical composition, will the broadcasting of such compositions be considered a public performance under the present law?

Let us continue the argument for the defense by a philosophical consideration of what radio apparatus is. It is a hybrid among the sound-producing instruments. It is unlike a cornet or a violin which must be played by the artist. Moreover the receiver must be considered as part of the entire radio apparatus. The transmitter is useless without it.

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Nor can we say that radio apparatus is like mechanical devices such as the phonograph or piano player. There is no record employed in transmitting. The transmitter is sound-operated. It is possible, however, to operate a transmitter directly from a record but it is not being done as yet in broadcasting. Radio apparatus is not mechanical. It is an electrical device dependent on the artist or on a separate sound producing agency. Nor is radio apparatus merely an amplifier of the sound, like a sounding board or other acoustical arrangement. The energy projected into space is not sound energy but electromagnetic waves. If there be amplification, it is amplification of electrical energy.

Here then is an instrument different from anything specifically mentioned in or contemplated by the copyright laws. The sound heard at the receiver is not the original sound produced by the artist. The artist's note is first transformed into electrical waves which in turn are changed into a new group of sound waves. If this be a public performance, as the Court may decide, it certainly is a new kind of performance.

The position for a plaintiff or copyright owner may be briefly stated. The broadcasting of copyrighted musical compositions is a public performance because such music is made available to the largest audience in the world. The copyrighted song is thus given the largest possible publicity. Should a broadcaster be allowed to profit without compensation to the copyright proprietor?

Assuming that the broadcasting of "musical compositions" is within the copyright laws also, only stations which broadcast such compositions without profit are free to do so. Such stations are those owned by charitable, eleemosynary or educational institutions or by governmental agencies. Furthermore, no action lies against the government for infringement of a copyright as such action is in tort and the government cannot be sued in tort without its permission. Stations owned by manufacturers or dealers in radio apparatus and other goods or by agencies selling broadcasting service (not renting stations) are the ones which will be required to be licensed. As the Supreme Court said, if "the purpose is profit that is enough." Whether such purpose exists in any given case is a question of fact. Obviously the method of obtaining the profit here is different from the hotel and restaurant cases. In the latter cases the public paid on the spot. In the case of broadcasting, the profit may or may not be realized.

There is also the case of users of receivers. I passed a "radio restaurant" the other day in which the guests were being presumably entertained by radio. Some dealers also furnish radio concerts to attract the crowds. One can hear the music blocks away. If the broadcasters are liable under the copyright laws these users of receivers are also, unless they shut off the receiver every time a copyrighted song is announced. Nor would the fact that the broadcaster is licensed give such right to the user of the receiver, unless the license to the broadcaster specifically so provided.

Don't forget you can also be arrested for infringing copyrighted matter. Anyone who wilfully and for profit infringes a copyright or who knowingly and wilfully aids or abets such infringement is guilty of a misdemeanor.

In summary, no unauthorized radio station of any sort has the legal right to perform publicly musical selections known as "dramatico-musical compositions." It can't be done, even if not for profit. But there is some argument for holding that the radio rendition of "musical compositions" is not an infringement, even though the purpose is profit. If the courts decide the argument is not a good one, only such persons can broadcast or perform by radio such musical compositions, as do not do so for the purpose of profit.

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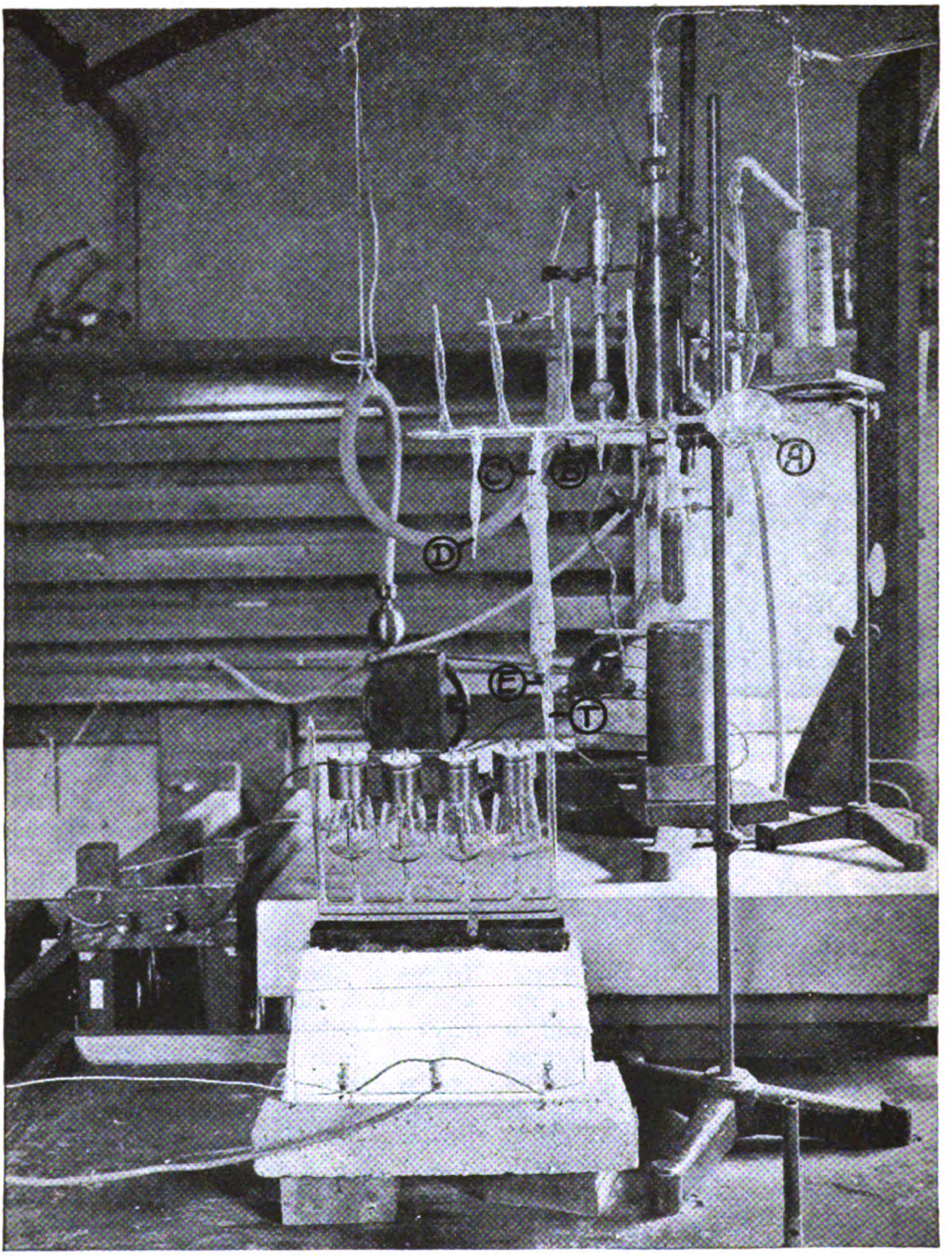

From a photograph made for POPULAR RADIO

THE APPARATUS USED FOR PUMPING AND PRIMING THE TUBES

FIGURE 1: *A, is the glass bulb which holds the supply of K-Na; B, is the piece of blown-glass pipe that leads to the evacuating pumps; points C, D, and E, are points that are sealed off or opened during the process, and T, is the tube through which the vacuum tubes are exhausted and primed. The other apparatus consists of the pumps, the pressure gauges and the heater oven.*

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THE NEW AND REMARKABLE

Alkali Vapor Tube

How the sensitivity of a vacuum tube is increased over 300 percent by the injection of potassium-sodium during the evacuation period.

By HUGH A. BROWN *and* CHARLES T. KNIPP

THE capacity of the new alkali vapor detector tube to function efficiently as a detector at low plate voltages is a matter of significance in the radio world. A description of the laboratory procedure in preparing these tubes, and a brief description of some newly discovered characteristics is of more than passing interest to the radio experimenter.

The material introduced into these tubes is an alloy of potassium and sodium, and has the appearance of mercury, which *must be prepared and handled only in a high vacuum.** A brief description of the method of filling the tubes follows:

Standard tungsten filament amplifier or detector tubes were connected to a "manifold" as shown in Figure 1. The glass bulb portion of two or more three-electrode tubes were fused in a vertical position onto a horizontal glass manifold. This manifold was connected through a "T" tube, one branch of which, B, led to the evacuating system, and the other to the *K-Na* alloy supply tube A. The evacuating system consisted of a charcoal tube in liquid air, a phosphorus pentoxide tube, a mercury vapor trap also immersed in liquid air, a McLeod gauge, a mercury condensation pump, and a supporting rotary oil pump, all shown in the illustration. The supply tube A, had a number of branch outlets, each branch being drawn down into a slender tube D, and also provided with a constriction, for the introduction of the alloy into the manifold and for subsequent sealing off. Connection between the outlet tube and manifold was made by heavy-walled rubber tubing sealed with rubber cement and tightly wired down.

When a pressure of the order of 10^{-4}mm. of mercury was reached, the tip at D, which was previously nicked with a file, was broken off by sharply bending the rubber tubing. The evacuation was continued, and, in order to completely as possible evacuate the tubes, the filaments were kept incandescent and also, 150 volts were applied to the plates. This evacuating process was continued until the tubes (which had been previously connected to receiving circuits) functioned best as detectors with 60 to 80 volts on the plates. This test indicated that the tubes were fairly well evacuated.

The supply tube A, was then tilted up and a little of the alloy was allowed to run down into the manifold; after that, tube A, was sealed off at C. To guard against possible leaks, due to the rubber connecting tube, another seal off was made at E.

The oil bath with its electric heater attached was now raised so that the horizontal manifold was immersed in the oil. The bath was gradually heated, with the pumps going, and ultimately the temperature was raised to about 230°C., at which temperature the alloy was fully vaporized. The vapor then passed through the capillary tubes, connecting the manifold to the electron tubes, and was condensed on the cool walls of the latter, forming a thin film,

*The preparation of this material is described in a paper by the authors published in the December, 1922, issue of the *Proceedings of the Institute of Radio Engineers.*

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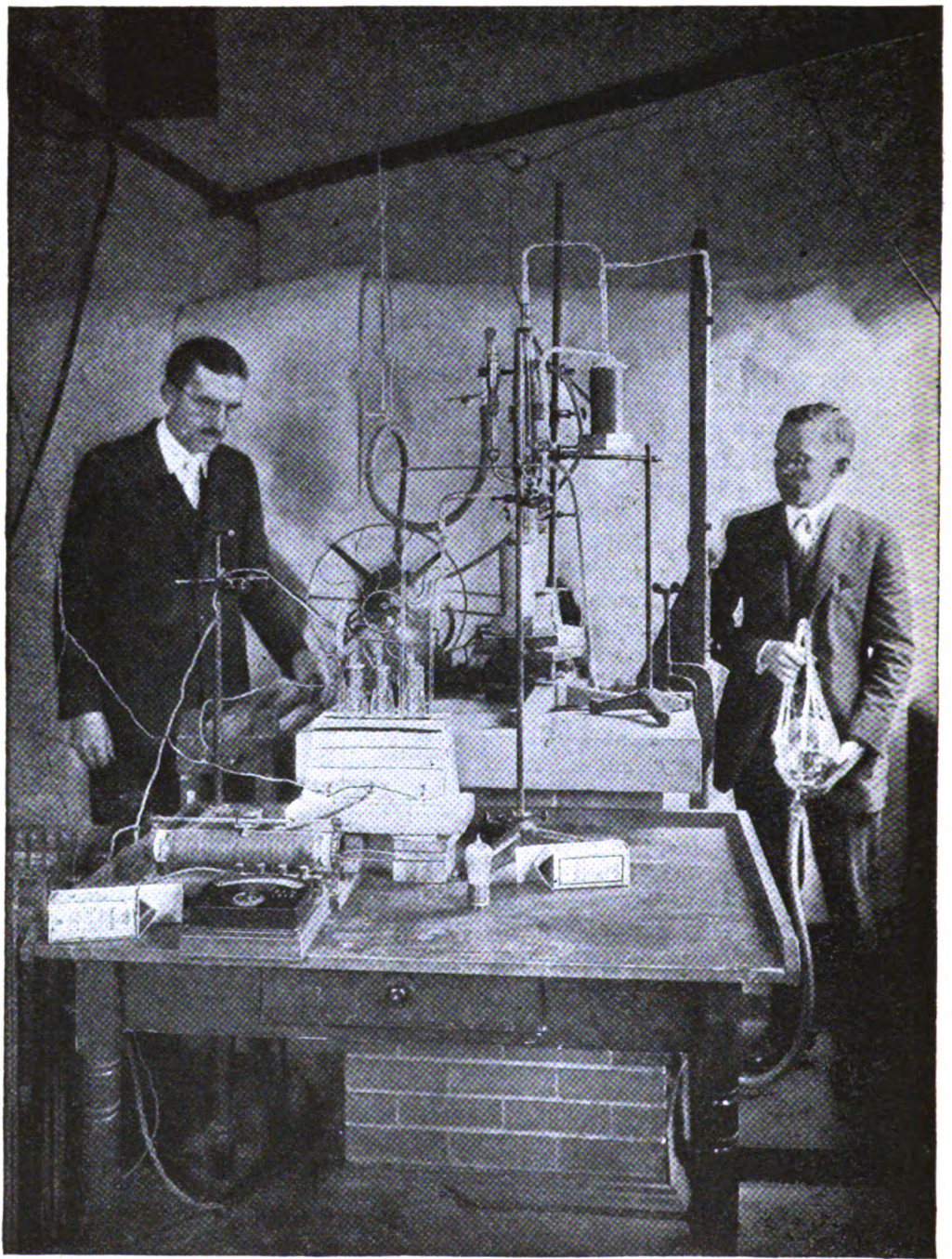

From a photograph made for POPULAR RADIO

THE AUTHORS DEMONSTRATE THE "SET-UP" FOR PRIMING

FIGURE 2: *At the left is Dr. Charles T. Knipp, head of the Physics Department of the University of Illinois, and at the right is Dr. Hugh A. Brown, associate of the Department of Electrical Engineering. They are injecting a small quantity of potassium-sodium alloy into the tubes during the process of evacuation.*

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at first of varied purplish hues, but shortly becoming silvery white, when the deposited film became thicker. Heat, coming to the bulbs by reason of being mounted directly over the oil bath, was intercepted by strips of cardboard and by turning on an electric fan. The filaments were kept incandescent at nearly normal filament current during this distillation process, thus preventing a deposit of the alloy on the inner metal parts of the tube, as well as aiding in the process of evacuating. After the inner walls of the bulb were well covered with the alloy, the oil bath was removed, and the tubes were sealed off. The pressure throughout the final stages of priming was maintained at approximately .00004 mm. of mercury. The action of the alloy within the tube is to "clean up" the remaining traces of air, and hence the vacuum actually *improves* with time.

It is extremely important to clean all glass and rubber tubing with *aqua regia* and distilled water, otherwise the alloy will stick to the walls of the tubing. The authors prefer to construct new manifolds rather than attempt to clean the used ones, also to use fresh rubber tubing each time. In order to facilitate distillation in the bulbs, the sealing off strictures should be fairly large—about 1 to 2 mm. (inside diameter). Any of the alloy condensed in the stricture should be evaporated gently, before attempting to seal off, as excessive heat will burn the alloy and give it a brown color.

Figure 2 shows a photograph of the authors of this article at work "priming" some radiotron tubes in the research laboratory. The device on the right is the McLeod vacuum gauge, and when the photo was taken the mercury "cistern" of this gauge was being raised so as to read the pressure. The rheostat on the left was being adjusted so as to increase the temperature of the oil bath to allow the alloy to evaporate faster. The photographs give the readers some idea of the complexity of the equipment that is required for such a seemingly simple job. The glass blowing requires long and tedious work. A tube that has already been primed is shown on the table beside the apparatus.

NOTE

A great deal of quantitative data has been obtained by the authors on the characteristics of these alkali vapor tubes, as is shown in the I. R. E. paper (see note above); a brief summary of the performance of the tubes as detectors and amplifiers will be of further value to our readers.

1. Alkali vapor tubes are *sensitive detectors at any plate voltage from 0 to 60 volts*, but are most sensitive at plate voltages ranging between 8 to 10 volts.

2. Laboratory tests have indicated that these tubes are *more than three times as sensitive* on weak damped-wave signals as the conventional gas-content detector tubes.

3. The adjustment of plate voltage and filament current for best results is far less critical than for gas-content tubes. A 50 percent change from the best plate voltage produces less than 20 percent decrease in audibility, as compared to 5 percent allowable variation for the gas-content tubes.

4. The tubes are steady, more selective as to wavelength than the ordinary vacuum tube, and *give absolutely distortionless reception.*

5. The high temperature of the filament is necessary to make the potassium-sodium alloy vapor active. A poorly evacuated tube can be made to perform like a high-vacuum tube by raising the filament temperature.

6. The best plate voltage to use is about 8 or 10 volts. With this voltage, users in the vicinity of Urbana-Champaign, Illinois (where the tests were made), report excellent results. When using only the positive filament-drop, with no additional "B" battery, the writers have often received broadcasting stations in Kansas City, Atlanta, Schenectady, and Pittsburgh, using a two-variometer type of regenerative receiver with an antenna 12 feet above the ground and 40 feet long, and with no amplifier. The reception from these stations was fairly loud and very distinct.

Again, using an antenna 40 feet high, and with no external "B" battery, broadcasting stations in Los Angeles, Cal., were received fairly loud. The above stations could even be heard faintly with the plate-circuit return connected to the negative filament lead, and with no "B" battery. With these conditions the tubes were also used as beat receivers of the autodyne type, receiving high-power stations on the coasts, when using the negative filament-drop as the sole plate potential.

—EDITOR

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THIS STATION HAS BEEN HEARD THROUGHOUT ALL NORTH AMERICA

Its owner is a typical amateur, Charles T. Asbury (3ADT) of Oak Lane, Pa. "My station has been heard in every state of the Union, Canada and Panama," he reports.

THE NEW VOICE THAT IS BEING HEARD

AROUND THE WORLD

Amateur radio knows no geographical boundaries. The new and wonderful world of the ether has extended beyond the artificial barriers of countries and has become inter-continental in scope. Some of the remarkable long-distance work of amateurs has recently been checked up by the U. S. Navy; the results are published for the first time in the following article.

By COMMANDER STANFORD C. HOOPER, U. S. N.

BY the radio amateur of our distant Territory of Hawaii, the United States may be visualized as a vast honeycomb of amateur stations within a huge beehive of sound.

As he "listens in on the United States" from his vantage point out near the center of the North Pacific Ocean, he overhears conversations in the "dot and dash language of radio" going on through space between his brother amateurs whose 17,000 odd licensed transmitting stations are scattered all over this broad land, ranging

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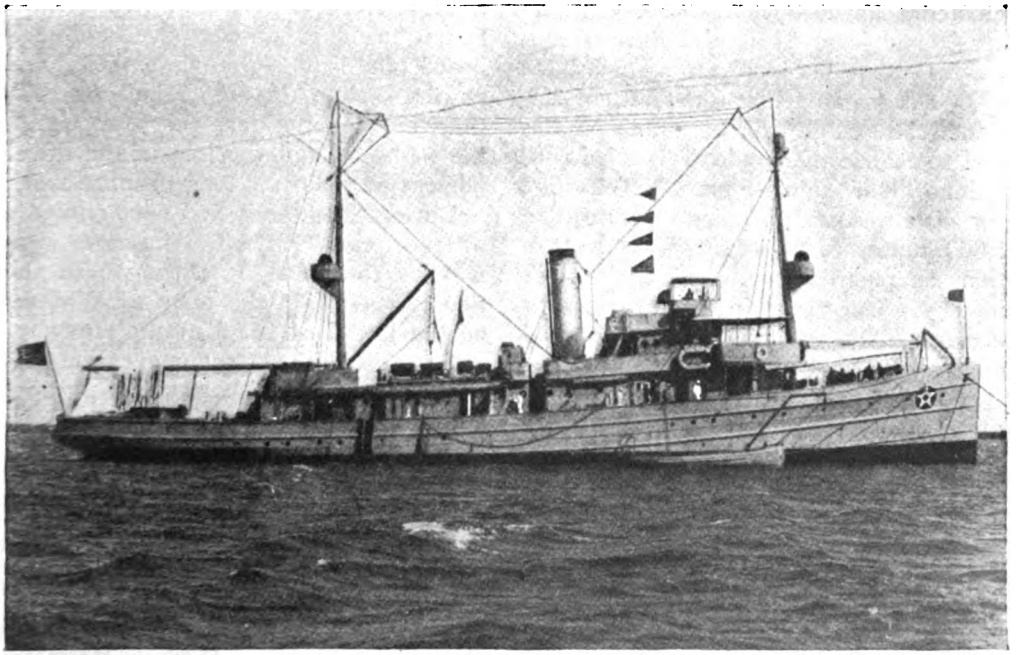
in locations as they do all the way from the state of Washington on our Pacific seaboard to Florida on the Gulf of Mexico; from the Canadian border on the north to the Mexican border on the south; from California to Maine.

Not only is the dot and dash language of amateur radio telegraphy from all sections of the United States thus brought to him with lightning-like speed on those distant islands situated more than two thousand miles from the nearest point on our Pacific seaboard, but in some instances he also hears the *voices* of his brother amateurs conversing with one another through space by the medium of radio telephony.

Moreover, as a full fledged radio amateur, he is not restricted to "listening in" only. His station is equipped with a transmitting set as well as a receiving set and he can thus "talk" as well as listen.

Although the amateur radio transmitting station, with its antenna suspended from the house top, may appear diminutive in dimensions as compared with the great high-power stations of the navy and of the commercial radio companies; although its juvenile transmitting wave is restricted by law to a length of 200 meters as against the waves ranging from 300 meters to the monster waves of 20,000 meters employed by the government and commercial stations; although he is also limited by law to an input power of only 1,000 watts (one kilowatt) with a consequent current value flowing in his antenna system rarely in excess of 10 amperes, whereas in the high-powered stations the input power has reached as high as 500,000 watts (500 kilowatts) with a consequent antenna current of 15 amperes to 700 amperes or more, yet in spite of all these handicaps he succeeds in covering remarkable distances through space, sometimes



Official, U. S. Navy

HOW THE NAVY CHECKED UP AMATEUR RADIO STATIONS

The U. S. S. Sea Gull *was fitted up with radio apparatus and was then dispatched to the east coast of the Island of Oahu in the Pacific—where the stations noted in this article were logged.*

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actually equalling those of the high-powered stations.

The amateurs have already successfully bridged the 2,000 odd miles of distance intervening between the Hawaiian Islands and our Pacific seaboard during the seasons of the year most favorable for radio communication —the autumn and winter months.

Communications are now exchanged back and forth during these months, with little, if any, difficulty, especially during the hours of darkness. Under exceptionally favorable conditions, communications are actually exchanged with inland stations situated as far eastward as Chicago and Detroit.

This will illustrate, on the one hand, the vagaries in radio communication, and on the other hand, the remarkable advances made by the amateurs in the development of the radio art within their restricted field of operation as regards wavelength and power input.

It is not intended to imply that the amateurs have thus far been *unnecessarily* restricted by governmental regulations. One need only to visualize the 17,000 odd amateur transmitting stations scattered all over the United States and to realize that under favorable conditions their signals may be effective for distances of 100 miles to more than 5,000 miles, to appreciate that restrictions as regards wavelength and power input *are necessary* in the interests of decreased interference to the essential government and commercial services.

Moreover, the amateurs of the United States are permitted far wider latitude than are those of any other country in the world, amateur radio operation being actually prohibited in most of the European and Asiatic countries.

As a result of the comparative freedom of action accorded the radio amateurs of America they have progressed in the development of the radio art within their sphere to such an extent that they now enjoy an acknowledged position of pre-eminence in amateur radio throughout the world.

Their logical ultimate goal, however, is world-wide communication by amateur radio, and it is not inconceivable that they will eventually achieve this end.

Communications exchanged during the favorable autumn and winter months of the year between amateurs whose stations are situated along our Pacific seaboard and the amateurs in the Hawaiian Islands is not, of course, comparable with the reliable day and night service rendered every day in the year by the high-power stations of the navy and the commercial companies.

The high-power radio telegraphic service between our California coast and the Hawaiian Islands is absolutely reliable every day in the year, regardless of static conditions, except for the unaccountable brief sunrise and sunset "fading" periods which occur each day.

Of course the amateurs cannot render service of this quality but that they *have* succeeded in bridging the intervening distance between our Pacific seaboard and Honolulu with their low-powered, short-wave sets indicates that they are keeping not very far behind the high-powered services in the development of radio for long distance work.

During the autumn and winter months of the year 1921, an American amateur by the name of Dow, whose station is located in the town of Wailuku on the Island of Maui of the Hawaiian group, established communication, by radio, not only with amateur stations situated along our Pacific coast but also with others situated in our middle western states.

The juvenile 200-meter waves created by amateur stations thus not only effectually spanned the broad expanse of waters of the North Pacific Ocean but also the lofty peaks of the Sierra Nevadas and the Rocky Mountain ranges and the vast plains of our western states as the amateurs talked back and forth to one another. The

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From a photograph made for POPULAR RADIO

AN AMATEUR STATION FAMED FOR LONG-DISTANCE TRANSMISSION

Experienced amateurs to whom the name of A. B. Tyrrell may be unfamiliar will be quick to identify him by his call letters 2BML. His station at Riverhead, Long Island, is known throughout the country for DX work.

performance was repeated during the year 1922 and among an ever widening circle of western amateur stations. In addition, amateur stations located along our Atlantic seaboard were also "picked up" at Wailuku, although communications were not actually exchanged between the Atlantic seaboard stations and the Wailuku station as was the case with the western stations.

These results were regarded as being so remarkable that experiments were undertaken during the month of October, 1922, by radio technicians attached to the navy's radio laboratory at Pearl Harbor on the Island of Oahu, in order to ascertain whether receiving conditions on the Island of Oahu were equally as good as those on the Island of Maui, and to confirm the reports of previous amateur performances.

The experiments of the navy radio men were made during their leisure time after laboratory working hours between 3.00 P.M. and 3.00 A.M. Honolulu local time.

This enabled observations to be made during intervals when both daylight and darkness prevailed over the area under observation.

The Hawaiian Islands constitute one of the few favored areas of the world

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for radio reception, as static is rarely experienced in these islands.

A radio peculiarity of the Hawaiian Islands is that the heaviest static season, such as it is, occurs there during the months of September and October instead of during the months of June, July and August as in the United States and elsewhere. Intense atmospheric disturbances such as prevail over the United States during the summer months are rarely experienced in Hawaii even during the months of September and October, although thunder storms with accompanying static occur from time to time regardless of the season of the year. These static storms prevail for not more than twenty-four hours duration and they are of infrequent occurrence. On the whole, static is far less prevalent in the Hawaiian Islands than it is in the United States.

A temporary receiving station was established on the shore line of the Island of Oahu with an unobstructed field between the station and the mainland of the United States.

The temporary installation was made in the buildings of the Makapu Lighthouse. Three different types of receiving antennas were temporarily installed for comparison as to their effectiveness.

One antenna consisted of the ordinary overhead antenna of one wire 150 feet long, suspended approximately 60 feet above the earth.

The other two consisted of Beverage antennas, one whose length was 656 feet, the other was 1,312 feet long.

The Beverage antennas consisted of single lengths of wire suspended 8 feet above the ground. The free ends of the Beverage antennas were connected directly to ground through resistances of about 540 ohms with the free ends pointing in the general direction of the United States.

It was found in connection with these experiments that the exact length of the Beverage antenna wire, the plane in which placed, its elevation above surrounding earth, the effective insulation of the wires from their supports, and the value of the resistance in the free ends, all exerted a marked influence on the strength of incoming signals.

A simple regenerative circuit, audion and two stages of audio frequency amplification, was employed. Good results were obtained by the use of either of the three different antenna systems, and utilizing the ordinary overhead type antenna, amateur stations situated as far eastward as Chicago were readily picked up.

The 656-foot Beverage antenna, however, was found to be approximately 50 percent more effective than the ordinary overhead antenna, and the 1,312-foot Beverage antenna proved to be approximately fifty percent more effective than the 656 foot antenna.

However, the prevailing static increased in strength proportionately with the strength of incoming signal and after some preliminary testing it was found that the 656-foot antenna gave the more generally satisfactory results and the other two antennas were therefore discarded.

It may be well to explain here that this 656-foot antenna as finally utilized throughout the observations, extended from a small washhouse situated on a plateau about one thousand feet above the water and over the edge of the cliff to another point about four hundred feet above the water.

The antenna suspended at this elevation was generally from ten to seventy-five feet away from the edge of the cliff. The efficiency of the antenna as a collector was favorably influenced by this high location.

Experiments were made with different types of vacuum tubes which were available at the laboratory, and it was found that the type UV-200 tube, utilizing from twelve to sixteen volts on the plate, gave best results as a detector.

The navy standard C. W. 933 tube gave best results in the first stage of

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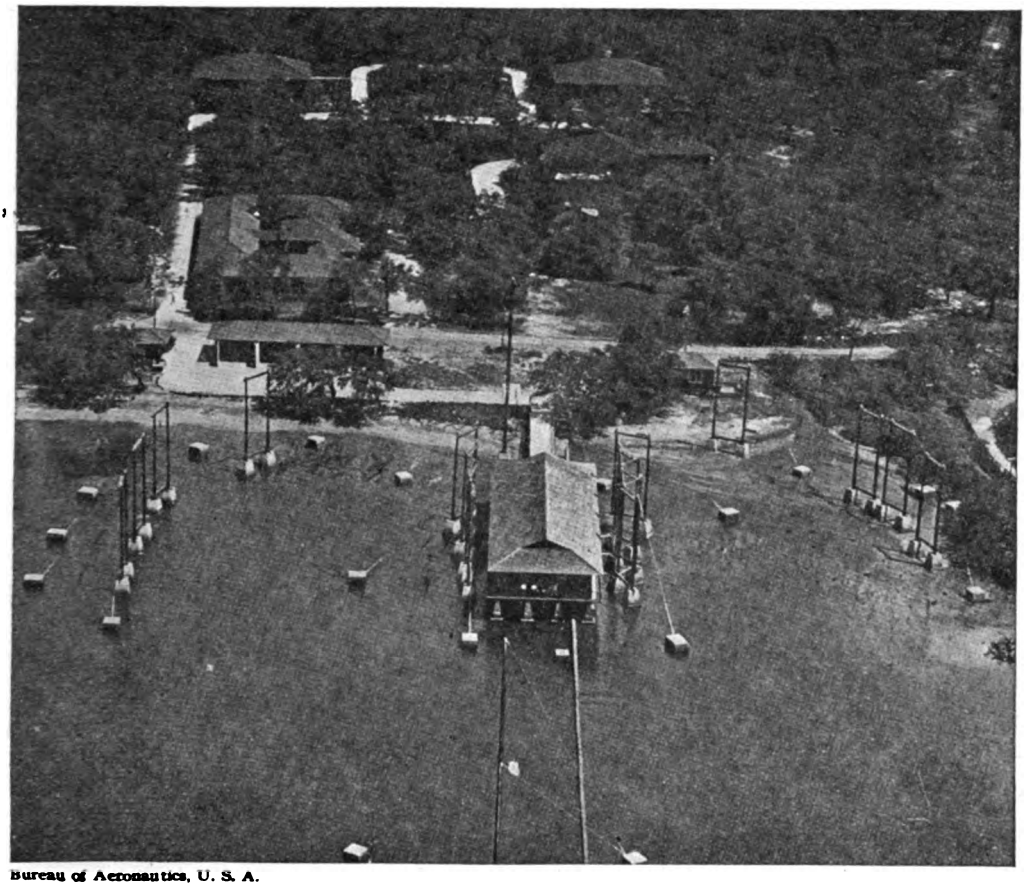

Bureau of Aeronautics, U. S. A.

WHERE THE NAVY LISTENED IN ON THE AMATEURS

During their spare time the officials of the naval radio station at Pearl Harbor in the Hawaiian Islands made a quiet study of the reception of amateur signals from the United States, 2,000 miles distant.

audio frequency amplification while the navy standard C. W. 931 five-watt power tubes gave best results in the second stage of amplification.

Experiments were also made with various types of audio frequency transformers available, the General Radio transformers finally being chosen for this work.

Using the installation and equipment as outlined in the foregoing, observations were begun during the daylight hours.

The following amateur stations along our Pacific seaboard were copied without difficulty during the daylight hours around 3.00 P.M. Honolulu local time.

Call	*Location*	*Owner*	*Watts*
6EN	Los Angeles, Cal.	H. A. Duvall	1,000
6BIG	San Rafael, Cal.	C. E. Walsh	1,000
6ARF	Woodlawn, Cal.	J. Duggan	500
6AK	Walnut Grove, Cal.	L. D. Mealer	1,000
6BCR	Alameda, Cal.	C. Foresman	500
7BJ	Vancouver, Wash.	Geo. Sturley	890
7SC	Aberdeen, Wash.	W. A. C. Hemerich	500

During the hours of darkness and up to 3 o'clock the following morning, 40 different stations situated in the United States within the comparatively "near-by" sixth radio district comprising the states of California, Nevada, Utah, Arizona and the Territory of Hawaii, were logged.

In addition the following distant stations were logged as the amateurs exchanged messages, conversed among themselves, or sent out conventional

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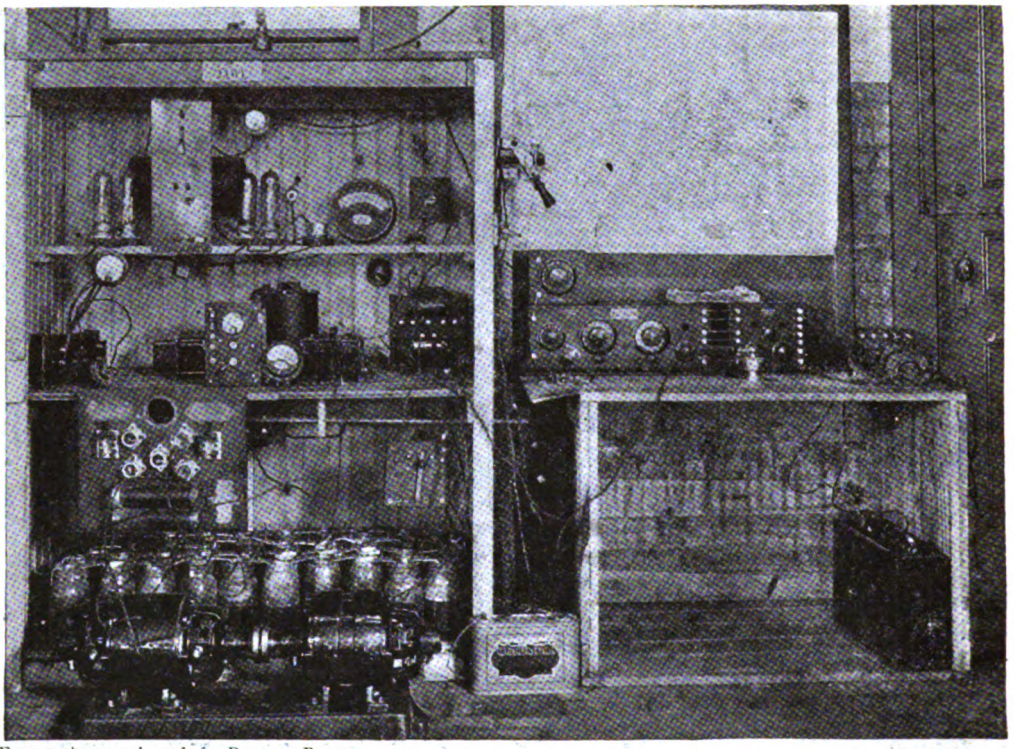

From a photograph made for POPULAR RADIO

THIS STATION HAS BEEN LOGGED IN EIGHT COUNTRIES

The long-distance records hung up by R. S. Johnson of Red Bank, N. J. (2AWL), include receptions in England, France, Switzerland, Cuba, the Azores and Hawaii.

signals. It will be noted that this list represents all of the other eight radio districts into which the United States is subdivided.

Call	*Location*	*Owner*	*Watts*
1BKA	Glenbrook, Conn.	Jay E. Brown	100
2FW	New York City	C. V. MacPherson	990
2LO	Highland Park, N. J.	N. Dunham	50
2FZ	New York City	F. Frimerman	50
2BGM	New York City	W. P. Inman	10
2AFB	Brooklyn, N. Y.	H. C. Stenger	36
2GO	Albany, N. Y.	H. G. Mulligan	50
2AWL	Red Bank, N. J.	R. S. Johnson	100
3AUU	Petersburg, Va.	W. M. Lamb	300
3CO	Baltimore, Md.	N. B. Falconer	450
3DH	Princeton, N. J.	D. W. Richardson	660
4KM	Atlanta, Ga.	L. K. Rush	500
4FG	Athens, Ga.	M. G. Nicholson, Jr.	495
4ID	Salisbury, N. C.	J. H. Robertson	200
4GH	Asheville, N. C.	E. A. Jackson	100
4BV	Savannah, Ga.	J. E. Hodge	250
5SK	Fort Worth, Tex.	M. R. Sanguinet, Jr.	150
5KC	Plaquemine, La.	Vincent Rosso	500
5PX	Fort Worth, Tex.	E. C. Tipton	500
5SM	Dallas, Tex.	Amos L. Daniel	1,000
5GV	Houston, Tex.	A. B. Ellis	500
5NK	Houston, Tex.	E. L. Lester	1,000
5PB	Houston, Tex.	James Greenwood	500
5UO	Wichita Falls, Tex.	J. R. Martin	20
5SF	Fort Worth, Tex.	Houston Hendrix	25
5TC	Fort Worth, Tex.	Allison Wilmer, Jr.	50
5AEC	Oklahoma City, Okla.	R. L. Fish	24
5EO	Waco, Tex.	J. R. Whitworth	1,000
5EK	Memphis, Tenn.	David G. Botto	500
5AG	Dallas, Tex.	J. S. Lowry	250
7SC	Aberdeen, Wash.	W. A. C. Hemerich	500
7BK	Seattle, Wash.	H. F. Mason	490
7HM	Great Falls, Mont.	Mervin Elton	450
7BJ	Vancouver, Wash.	Geo. Sturley	890
7UU	Seattle, Wash.	Robt. Waskey	500
8CAJ	Binghamton, N. Y.	Joseph Quilter	50
8BO	Detroit, Mich.	R. E. Chapin	500
8BFM	Akron, Ohio	C. J. Sonneberger	500
8BXA	Ann Arbor, Mich.	E. W. Eslinger	27
8BEF	Cleveland, Ohio	F. D. Tidball	465
8CGP	Corry, Pa.	L. S. Gordon	960
8BXH	Columbus, Ohio	H. C. Hedges	200
8ANB	Cleveland, Ohio	C. P. Goetz	20
8OW	Pittsburg, Pa.	Anthony Maz	550
8AGO	Pittsburg, Pa.	Biddle Arthurs, Jr.	1,000
8ALO	Pittsburg, Pa.	W. McL. Miller	270
8ML	Cleveland, Ohio	Frank Murphy	1,000
8BCO	Cleveland, Ohio	D. A. Crossley	1,000
8ND	Buffalo, N. Y.	N. W. Criqui	50
8ANJ	Coshocton, Ohio	W. C. Marlow	250
8PD	Cleveland, Ohio	Elmer Priebe	500
8CMJ	Buffalo, N. Y.	Rolland D. Mann	990
8SP	Fairmount, W. Va.	Albert Kisner	1,000
8AWM	Cleveland, Ohio	J. Kuenhold	100
8CBP	Detroit, Mich.	H. V. Simmons	250
8CF	Tiffin, Ohio	A. T. Gahris	25
9AUL	Minneapolis, Minn.	L. C. Smeby	1,000
9AMB	Denver, Col.	D. L. Hathoway	1,000
9BRC	St. Paul, Minn.	C. E. Swanson	250
9DPA	Oak Park, Ill.	John Liska	500
9BB	Chicago, Ill.	H. J. Buckley	440
9CIP	St. Paul, Minn.	F & D. Weyerhauser	1,000
9DSM	Omaha, Neb.	J. B. Platner	100
9DKY	Mason City, Iowa	M. H. Decker	21
9AW	Chicago, Ill.	P. S. Pfeiffer	500
9DTM	Denver, Col.	W. L. Fick	488
9AWM	Sleepy Eye, Minn.	L. V. Berkner	120
9GK	Fargo, N. D.	T. Reineke	660
9UU	Chicago, Ill.	R. W. Weisbach	100
9CP	Hammond, Ind.	J. R. Miller	1,000
9CG	Maywood, Ill.	R. J. Iverson	700
9AOG	Lawrence, Kan.	C. E. Himoe	500
9AWS	Minneapolis, Minn.	G. E. Zimball	1,000

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9CCV	Courtland, Kan.	Ed. Barricklow	32
9CFY	Colorado Springs, Col.	C. O. Ford	100
9IZ	Chicago, Ill.	Tom G. Seese	1,000
9AM	Chicago, Ill.	J. D. Cole	500
9BRG	Minneapolis, Minn.	C. L. Stong	25
9AUX	St. Paul, Minn.	H. Hediger	1,000

The air-line distance between the various cities and towns named in this list and the city of Honolulu in the Hawaiian Islands is in no case less than 2,000 miles and in some cases approximately 6,000 miles.

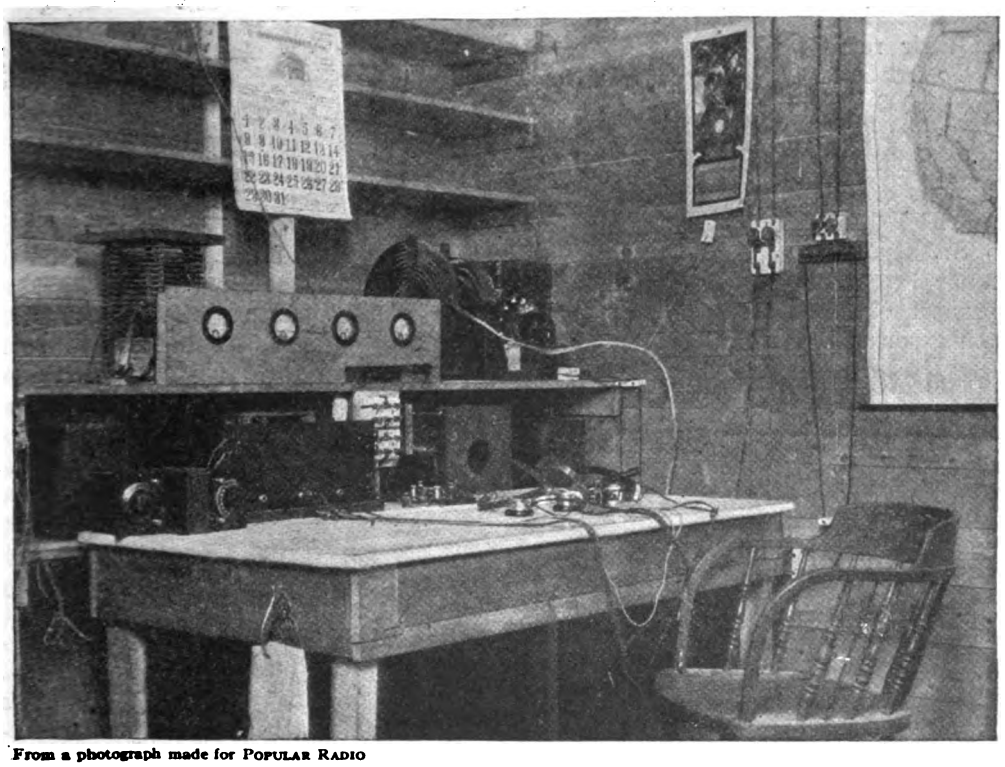
It is interesting to note that by far the greater number of amateur stations whose signals were picked up in the Hawaiian Islands were located in centers of large urban population rather than in rural districts.

As the maximum range of the most efficient of the amateur stations did not exceed 500 miles ten years ago, these results exemplify the rapid progress being made by the American amateur in the development of radio for long distance work. They also furnish food for thought for our sociologists, our statesmen, our business men, as well as our radio engineers.

The radio amateur has long been recognized as a national asset in connection with the national defense. Obviously, a body of 17,000 odd young men, gradually growing up to manhood, and thoroughly trained in the essential features of radio as the amateurs are, constitutes an ideal radio reserve force.

The variable nature of radio is no more strikingly illustrated than in the results obtained in the Hawaiian Islands during the observations described.

In order to insure satisfactory service day and night, every day in the year, with ships at sea, stations of not less



From a photograph made for POPULAR RADIO

ONE OF THE GREATEST AMATEUR STATIONS IN THE WORLD

This remarkable station—one of the original group of twenty-three that first spanned the Atlantic—is 1ARY, owned by the University of Vermont at Burlington, Vt. It has been repeatedly logged in foreign countries.

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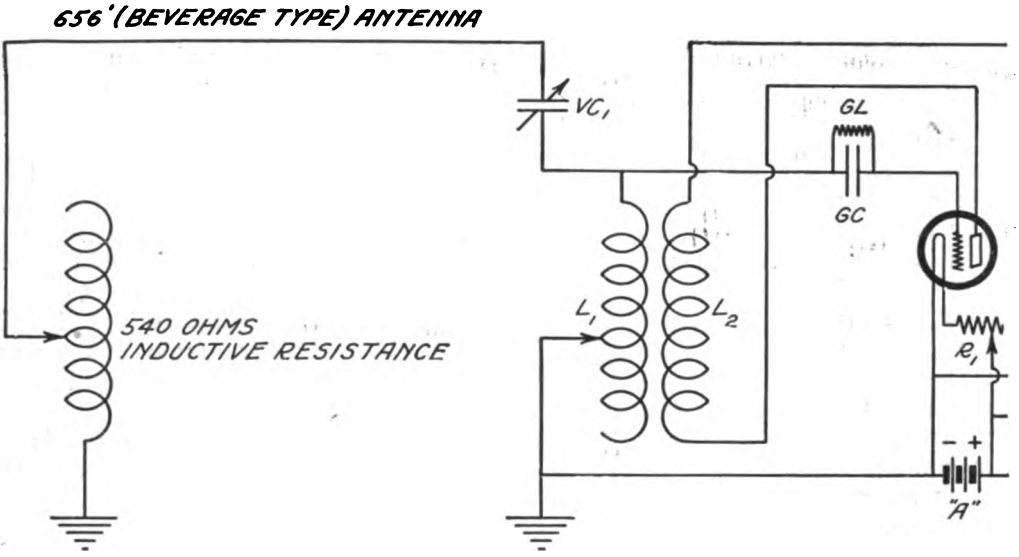

than 5,000 watts power have been established by the navy along our coasts at intervals of approximately every 200 miles, a distance which is considered as their reliable range.

To maintain constant service over the 2,000 mile stretch between San Francisco and Honolulu, both the navy and the commercial companies maintain stations ranging from 100,000 watts to nearly 500,000 watts.

Stations of such power are absolutely necessary for reliable continuous service. Yet, stations of only 1,000 watts power and sometimes even much less than 1,000 watts are effective not only for 200 miles or 2,000 miles but for approximately 6,000 miles, and judging from the strength of the incoming signals observed in the Hawaiian Islands, they were effective for still greater distances.

A review of the stations heard in the Hawaiian Islands during the observations described will show that signals from a number of stations of as low as 10 watts power were heard.

Let us segregate a few of the most notable cases of stations of extremely low power whose signals were effective for distances of 5,000 miles on the average. Their varying locations indicate clearly that no freakish conditions prevailed with respect to any one station.

Call	*Location*	*Owner*	*Watts*
2BGM	New York City	W. P. Inman	10
2GO	Albany, N. Y.	H. G. Mulligan	50
4GH	Asheville, N. C.	E. A. Jackson	100
5UO	Wichita Falls, Tex.	J. R. Martin	20
5AEC	Oklahoma City, Okla.	R. L. Fish	24
8CAJ	Port Huron, Mich.	J. C. Fountain	50
8BXA	Ann Arbor, Mich.	E. W. Weslinger	27
8ANB	Cincinnati, Ohio	C. P. Goetz	20
8CF	Tiffin, Ohio	A. T. Gahris	25
9DKY	Mason City, Iowa	M. H. Decker	21
9AWM	Sleepy Eye, Minn.	L. V. Berkner	120
9CCV	Courtland, Kan.	Ed. Barricklow	32
9CFY	Colorado Springs, Col.	C. O. Ford	100

In observations of this kind, where call letters consisting of a combination of one figure and several letters such as are assigned to all amateur transmitting stations, there is always the possibility of error on the part of the operator when "picking them out of the air." However, the radio men at the navy's radio laboratory at Pearl Harbor are expert radio operators as well as radio technicians; they are not likely to make mistakes "reading code."

Remarkable as these results are, therefore, they can doubtless be accepted as correct. In many cases the navy's radio men merely logged the call letters as they heard them, and did not know what the location of the station was, except as indicated generally by the figure in the call letter which de-

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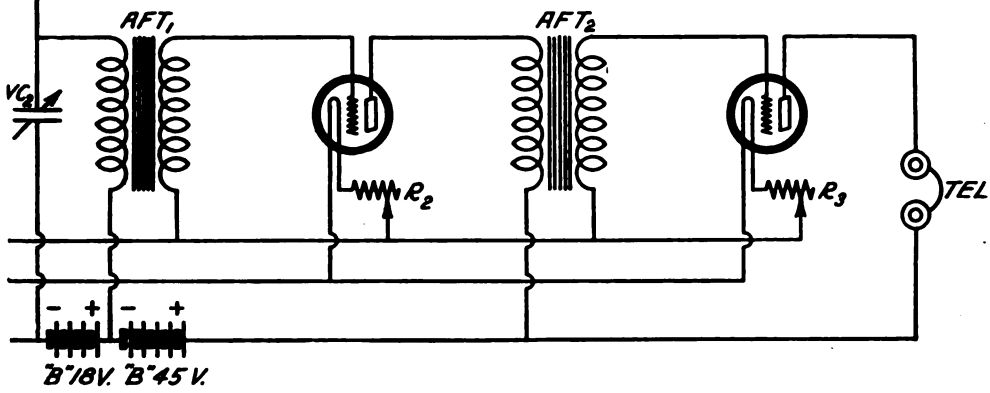
WIRING DIAGRAM USED IN THE TESTS OF AMATEURS

The circuit used at Hawaii by the Navy Department in the receiving tests with the amateurs on the mainland of North America. The proper way for connecting to the Beverage type antenna is also indicated.



noted in what radio district it was located.

A peculiarity was noted in that the signals from the amateur stations situated along our Atlantic seaboard and within our middle western states reached their maximum aural strength about 8 P.M., local Honolulu time, while those from stations situated along our Pacific seaboard did not vary in strength but maintained a uniform strength throughout the hours of darkness in the Hawaiian Islands.

In order to observe the incoming amateur signals on board ship as well as on land and to compare the simple receiving circuit used at the Makapu Lighthouse experimental station when used in conjunction with the ship's overhead antenna, this receiving apparatus was installed on board *The Sea Gull*, stationed at the Pearl Harbor naval base.

After the installation had been effected, *The Sea Gull* left the harbor and proceeded to the east coast of the Island of Oahu.

As soon as the vessel cleared the east side of the island so as to afford a clear unobstructed field toward the mainland of the United States, signals from amateur stations in the United States began coming in continuously.

Some of the stations which were logged on *The Sea Gull* during the hours of daylight, sunset, and darkness at Honolulu are given:

Call	*Location*	*Owner*	*Watts*
5HK	Dallas, Tex.	Robert W. Carol	1,000
5FV	Nashville, Tenn.	J. H. DeWitt, Jr.	1,000
5GV	Houston, Tex.	A. B. Ellis	500
5SK	Fort Worth, Tex.	M. R. Sanguinet, Jr.	150
5DI	Houston, Tex.	T. S. Depew	20
6AQJ	Tucson, Ariz.	J. H. Knost	1,000
7SC	Aberdeen, Wash.	W. A. C. Hemerich	500
7BV	Kelso, Wash.	C. Z. Kennedy	1,000
7TQ	Medford, Ore.	H. H. Howell	40
7GK	Evanston, Wyo.	C. H. Linsley	1,000
7SY	Eugene, Ore.	G. M. de Broekert	175
8BXI	Utica, N. Y.	Thos. S. Batson	500
8CGP	Corry, Pa.	L. S. Gordon	960
9AWM	Sleepy Eye, Minn.	L. V. Berkner	120
9AVQ	Denver, Col.	F. A. Hechendorf	1,000
9ANF	Lincoln, Neb.	H. C. Harvey	500
9BJI	Denver, Col.	F. L. Hicks	100
9BOQ	Blair, Neb.	N. G. Garner	500

In addition to these, more than thirty amateur stations within the state of California were logged.

It was observed that the fading of the amateur signals was very much less pronounced than that experienced with the longer waves and this peculiarity was noted at both the Makapu Lighthouse experimental station and on board *The Sea Gull*.

The comparative absence of fading in this case may have been due in part at least to the fact that the experimental station was located directly on the waters edge and *The Sea Gull* was like-

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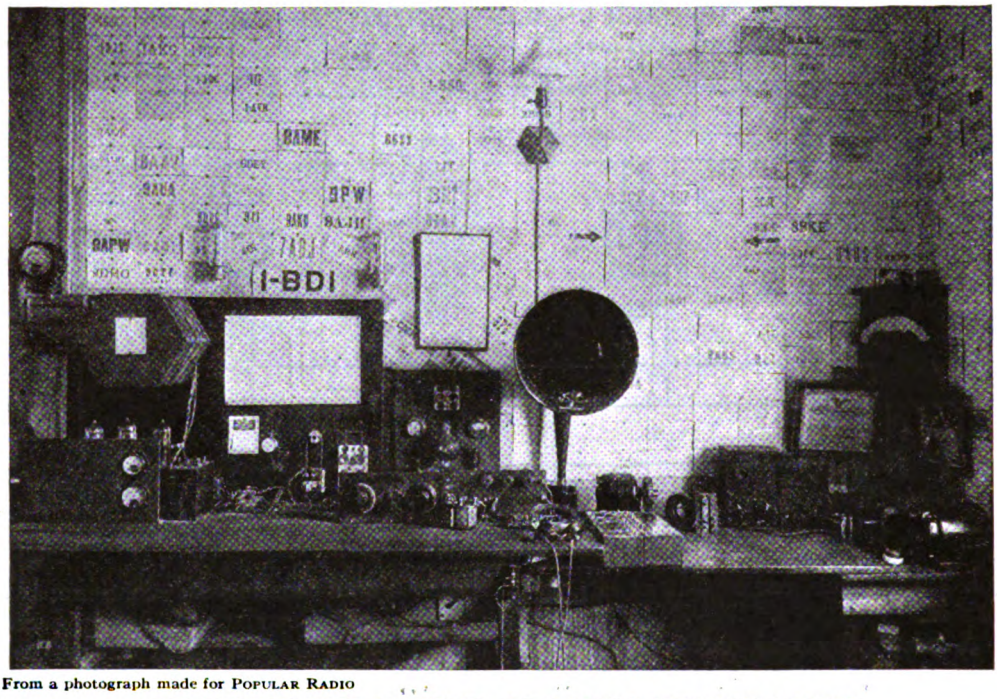

From a photograph made for POPULAR RADIO

AN IMPRESSIVE EXHIBIT OF LONG-DISTANCE WORK

The walls of F. E. Handy's station 1BDY at Orono, Maine, are literally covered with DX cards from fellow amateurs from all over the country.

wise favorably situated with respect to the incoming waves.

It is interesting to note in this connection that relatively less fading of signals on the long waves around 15,000 meters used by the navy and the commercial companies, occur at the navy's main receiving station at Wailupe than at the commercial station at Koko Head, although both of the stations are situated on the southeast coast of the Island of Oahu and are separated by an air line distance of only about three miles.

After observations had been made of the incoming amateur signals for two or three days with the results as outlined in this article, it was decided to make a temporary transmitting installation similar to that commonly employed by amateurs for the purpose of making brief experiments with a view to ascertaining whether or not contact could readily be made with amateurs on our Pacific seaboard, utilizing the amateurs' government-authorized 200-meter wave.

A vacuum tube transmitter of only 250 watts power was hastily improvised, a circuit commonly employed by amateurs being utilized.

A Radio Corporation 60-cycle step-up transformer was used on the available 500-cycle alternating current radio power supply for exciting the filament and plate circuits, available coils and condensers of as near correct value as could be found being employed in the improvised transmitter.

This transmitter was installed on *The Sea Gull* and connected to that vessel's ordinary overhead antenna. After broadcasting a few "CQ's" or "general radio calls" and "signing off" with the call letters of *The Sea Gull*, several amateur stations situated within the state of California were immediately heard calling *The Sea Gull* in turn.

Contact was thus established without difficulty with amateurs in the United

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States and the reports of previous amateur performances verified to the complete satisfaction of the navy's radio experts.

Conversations were exchanged with the following named amateurs during these brief tests:

Call	*Location*	*Owner*	*Watts*
6AWT	San Francisco, Cal.	B. Molinari	500
6KA	Los Angeles, Cal.	F. E. Nikirk	500
6JD	Los Angeles, Cal.	V. M. Bitz	500

By shifting to the ship's commercial wavelength of 600 meters, contact was also readily made with the commercial coastal station KPH at San Francisco.

It is performances such as described in this article that entitles the American amateur to the pre-eminent position he now holds in the radio of the world, and gives the "radio amateur" a status far different from that of the "radio fan."

Radio amateurs have a status in the radio world with respect to the radio fan comparable to that of the big league baseball player with respect to the baseball fan in the world of sport; to that of the motion picture star with respect to the movie fan in the realm of amusements.

To the radio amateur, the science of radio is a subject of study, investigation, experimentation and trial. To the radio fan it is primarily an agency for affording recreation and amusement.

The radio amateur speaks the dot and dash language of radio as fluently as he does the language of the spoken word. To him the dots and dashes coming through space comprising words, sentences and paragraphs, are as easily read as the layman reads a newspaper before his eyes.

To the radio fan the dots and dashes of the radio code merely constitute an unfathomable, unintelligible, jumble of meaningless sounds. The radio amateur understands the theory of radio and the functioning of the equipment and circuits. He knows how they function and why. He usually designs, assembles, and installs his own apparatus, both transmitting and receiving, purchasing only such complete parts as he cannot readily build himself. He adjusts his transmitter and antenna circuits to the authorized wavelength setting of 200 meters and he measures the wavelength emitted to insure that his station is properly "tuned." When ready for operation, he undergoes an examination at the hands of the Department of Commerce and obtains a license from that department to operate his station, a combination of "official call letters" being assigned to him which designates his station from all others in the realm of radio.

Thus equipped with a government sanction to operate his "station" he broadcasts "CQ's" to attract the attention of other amateurs and explores the ether through his receiving equipment for answering signals from other amateur stations and proceeds to make acquaintances through space and discuss the relative merits of his invisible station as reflected by the aural strength and quality of his signals.

It may be taken for granted that he loses no time in trying to establish a long-distance record in amateur radio transmission.

Although all radio amateurs are not boys, boys constitute by far the greater number of the 17,000 odd "owners" of American amateur transmitting stations.

In the license issued to the amateur by the Department of Commerce he is recognized as the owner of his station, no questions being asked as to the legal status of the property on which it is situated.

Thus his antenna may be suspended between the chimney tops, or the roofs of his father's house and barn and his transmitting and receiving apparatus installed in the garret or basement of his home or even in his bedroom, but nevertheless he is the officially recognized proud owner of his station in the world of radio.

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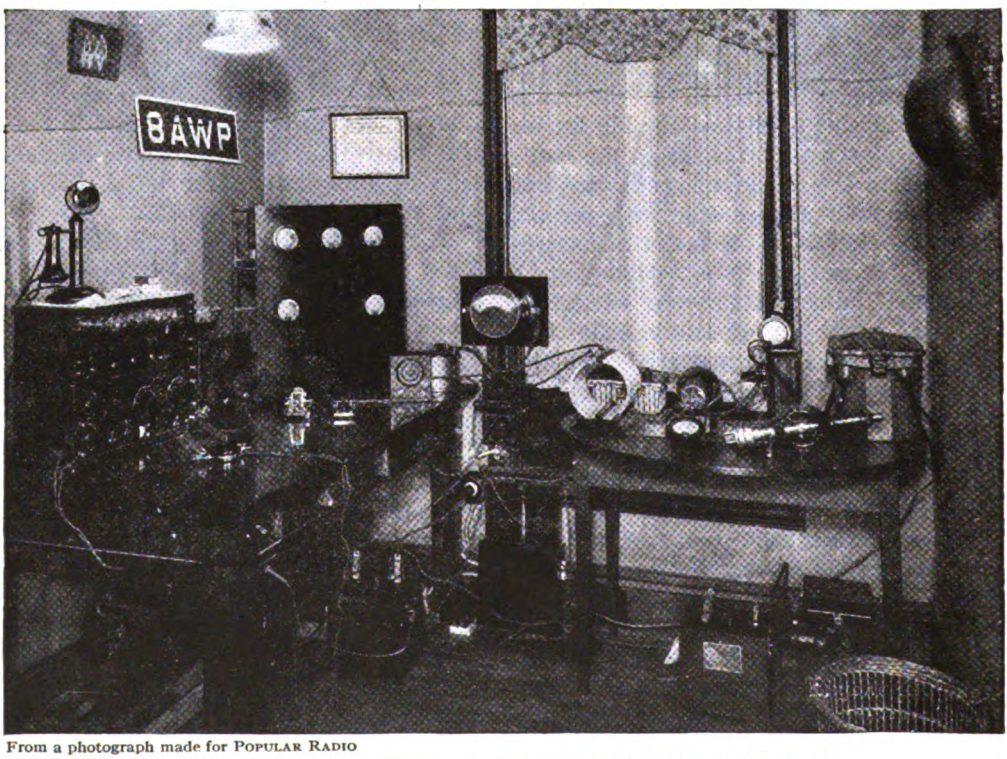
That the sphere of amateur radio is gradually being extended westward around the world by American amateurs is exemplified by the experiments described in this article. That it is also being extended eastward, has previously been demonstrated by tests as a result of which the Atlantic Ocean was successfully spanned.

The American amateur has continued to reach out in both directions until approximately one half the earth has now been spanned under the most favorable conditions for radio. And through his ingenuity and enthusiasm he has accomplished this noteworthy feat, in spite of the limited power on which he must operate and his restricted wavelength.

In view of the progress made by the amateurs since their advent into the world of radio about fifteen years ago, it is entirely logical to assume that they will eventually achieve world wide communication by radio.

It is obvious that when this result has been brought about, the American radiophone broadcasting stations utilizing their wavelengths of about 400 meters and not being restricted as to power input, will also have achieved world-wide ranges.

These, with our radio amateurs, will doubtless cause the American derivation of the English language to become a popular course of study in the schools and homes of foreign lands.



From a photograph made for POPULAR RADIO

A TYPICAL AMATEUR STATION THAT INDULGES IN INTER-CONTINENTAL COMMUNICATION

It is owned and operated by Samuel Woodworth of Syracuse, N. Y., whose call letters 8AWP have been heard throughout North America and abroad. The set in the corner underneath the license employs 5 50-watt tubes and has been heard repeatedly in Hawaii and off the coast of Chile. The large 250-watt tube set on the table by the window has been reported from England and France two or three times each month.

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¶ Some day, the scientists tell us, the "pocket radio set" will be as common as the watch is now. Here is a miniature set that shows what we may be coming to.

From a photograph made for POPULAR RADIO

IT IS TUNED BY THE TWIST OF THE WRIST

A unique miniature crystal receiver that requires only an antenna to make it complete for the reception of broadcasting

A Receiving Set in an Earphone

Tiny receivers—some of them so small as to be contained in finger rings—have fascinated radio fans to such a degree that some remarkably ingenious miniature sets have been devised. Here is a new one that has been found to be essentially practical.

By FREDERIC SIEMENS

THE development of the miniature receiving set is taking place so rapidly that it appears to be merely a matter of time when we shall be going about with vest-pocket radio devices in much the same way as we now go about with watches. The prospect certainly stirs the imagination. It brings up a vision of men and women going about their daily tasks with small black pill-box receivers strapped over one ear and small black cords extending from it to sensitive midget machines hidden in their clothes.

As a matter of fact, several such miniature receivers have already been made. A set that has special claim to notice is shown in the illustrations. One of these sets was presented to each of three hundred guests at a recent dinner at White Sulphur Springs. The banquet hall was wired to receive broadcast programs, so that the guests merely had to "plug in" to enjoy the

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entertainment that was provided for them.

This miniature set is fully equipped with a crystal detector and a single tapped coil, telephone ear-piece, flexible leads and plug. As shown in the illustration on this page, the whole set is mounted on a telephone headband; the telephone is fastened in the regular manner to one end and the set on the other end.

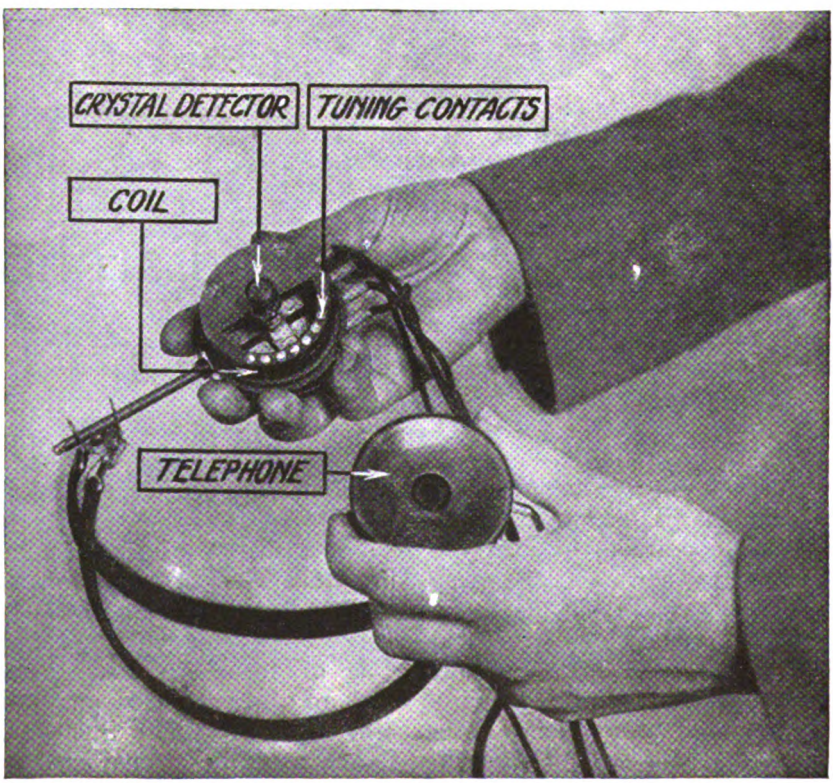
The detector is adjusted by means of the little knob on the set, and the wavelength is controlled merely by twisting the cap (which has not been shown in the picture) that contains the switch arm for making contact with the various contacts on the set.

All that is necessary to do to use the set is to connect it to a suitable antenna and ground.

It is not inconceivable that in the future we might have public antennas connecting to telephone jacks on the street lampposts; when that time arrives, all that the passerby would have to do, even with such a simple set as this, would be to take the plug out of his pocket and "plug in."

Then again, with the advent of the new miniature vacuum tubes which work on 1½ volts from a dry battery, we may reasonably expect to hear of a new set which can receive long distance signals without any aerial at all, yet that will be no more cumbersome than the set described herein.

At all events this miniature set points the way. It is concrete evidence that the vest pocket set can be made a practical piece of apparatus and one that some day every one will own.



From a photograph made for POPULAR RADIO

HOW THE "EARPHONE" WORKS

Note the seven tuning contacts and the clever arrangement of the small coil and the crystal—all encased in a bakelite container the size of a watch.

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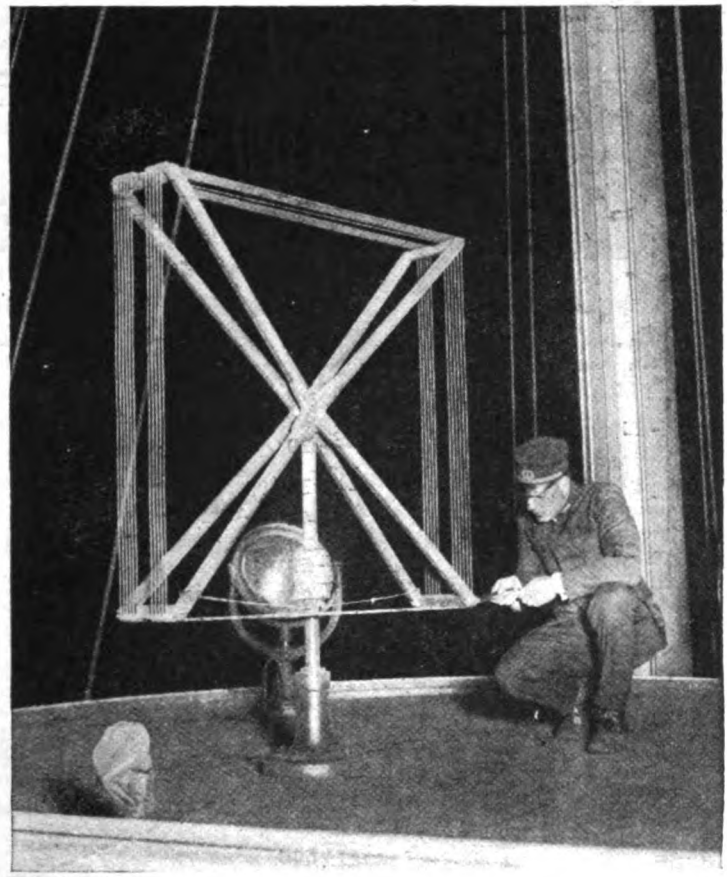

Kadel & Herbert

A LOOP ANTENNA INSURES HIGH SELECTIVITY

When used with supersensitive amplifying systems it is a valuable aid in doing away with static and interference. The loop shown here is located on the deck of a Navy compass station.

A MEASUREMENT CHART

FOR DETERMINING THE CONSTANTS OF A LOOP ANTENNA

ARTICLE No. 5

The previous articles contain charts *For Determining the Constants of Radio Circuits and Calculating Capacities of Condensers in Series,* in February, 1923; *For Determining the Dimensions of Your Coil,* in March, 1923; *For Determining the Capacity of a Condenser,* in May, 1923 and *For Determining the Capacity of Your Antenna,* in July, 1923.

By RAOUL J. HOFFMAN, A.M.E.

IN these days of modern radio when the multi-stage radio frequency amplifier, the super-heterodyne receiver, the super-regenerative receiver, and the various reflex circuit receivers have been coming into more or less general use, the loop antenna for receiving has been brought more into prominence.

The three outstanding advantages of the loop type antenna—its directional ef-

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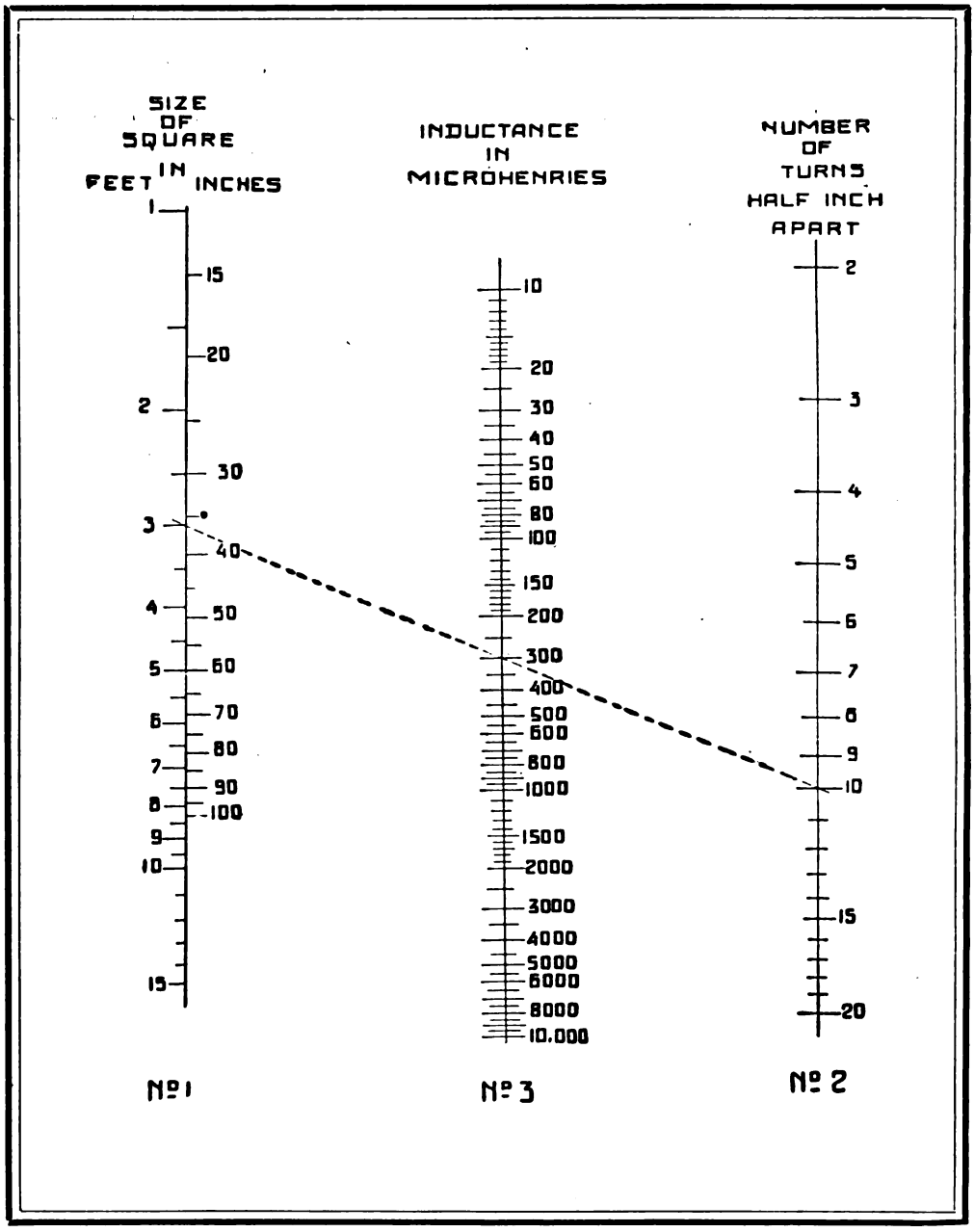

HOW TO USE THE CHART

PROBLEM: *If you should want to build a loop antenna that would have a dimension of three feet to a side, and you wanted to incorporate in the loop enough turns of wire to give an inductance of 300 microhenries, how many turns would you wind on it?*

SOLUTION: *First, connect the value 3 on scale No. 1, with the value 300 on scale No. 3, with a ruler, and carry the line out over scale No. 2. Then observe the value on scale No. 2 where the line crosses the scale—which value would be the correct number of turns of wire to use.*

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fect, the simplicity of tuning and the absence of the troublesome and bulky outdoor antenna—are important to the city fan who is interested in receiving only.

There are several standard receiving sets now being placed upon the market that incorporate the loop antenna. However, there are many people who make their own sets, and who are experimenting with radio frequency amplification who have occasion to design and build their own loop antennas.

And the question "How many turns of wire shall I wind on the loop" is not often answered correctly.

For their benefit we have prepared this chart, that tells exactly how many turns of wire to use for a given wavelength range. A loop antenna is almost universally tuned by placing it in shunt to a good variable condenser and this is all that is necessary in the way of tuning.

First of all, the wavelength range should be decided upon.

Then the size of variable condenser should be chosen for use with the loop.

With these two points determined the prospective builder may easily calculate the necessary inductance which must be used in the loop to cover the wavelength range chosen. The chart article in the February issue of POPULAR RADIO tells you how to do this.

When this inductance is known, you may then use the chart in the present article, for calculating the correct number of turns of wire to use to give the required inductance value.

The accompanying chart is based on the square form of loop, on which the wires are spaced ½ an inch apart.

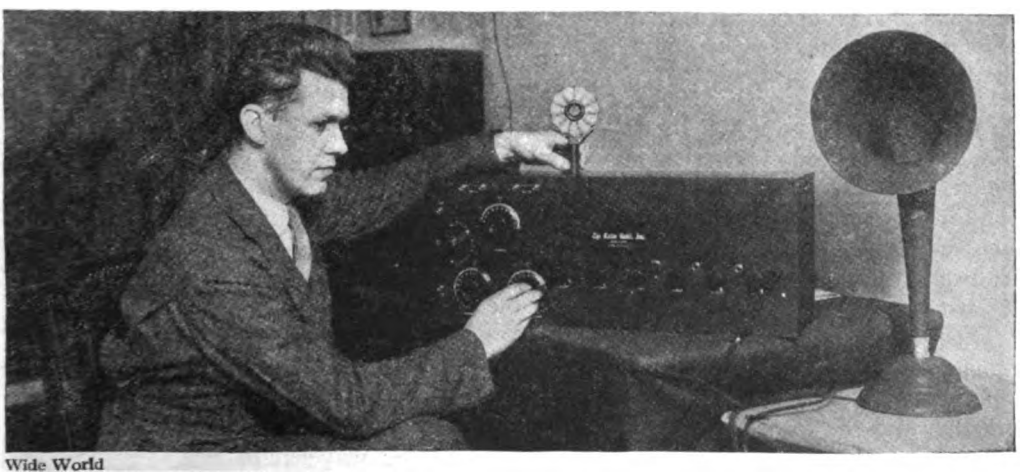
This form of loop should not be mistaken for the spiral loop.

When you use the chart, connect values on scale No. 1, with values on scale No. 3, with a ruler and read the number of turns required on scale No. 2.

Example:

To build a loop on a square form, 3 feet on each side, with the wires spaced ½ inch apart to have a total inductance value of 300 microhenries. How many turns of wire should be used?

With a ruler, connect the size of the loop, (3 feet), on scale No. 1, with the desired inductance value (300 microhenries) on scale No. 3. If this line, connecting the two points is extended over to scale No. 2 it will cross at the correct number of turns, (10 turns).



Wide World

AN ANTENNA SYSTEM SMALLER THAN YOUR HAND

With eighty-five feet of wire wound into a spiderweb coil that measures only three inches in diameter, Kenneth Harkness, a New York radio engineer, has received as far as Schenectady. He claims he has the smallest antenna system in the world.

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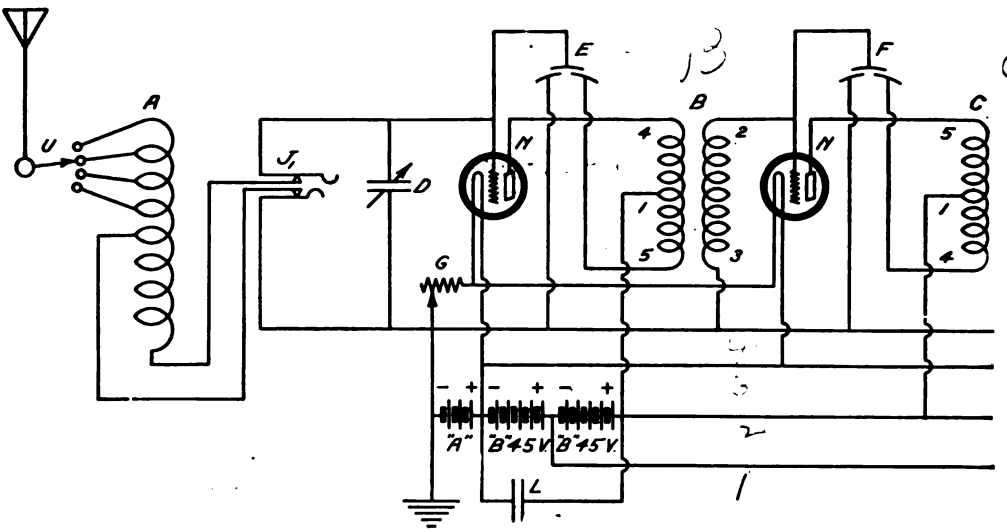

CIRCUIT DIAGRAM OF THE NEW 5-TUBE RECEIVER

FIGURE 1: *The electrical connections for the instruments employed in this circuit are here shown and the parts are designated by letters which reappear in the text and also the list of parts, the photographs and the working diagrams.*

HOW TO BUILD A *TUNED*

RADIO FREQUENCY RECEIVER

—At a Cost of About $60

The radio fan has heard much during the past six months of "radio frequency amplification." Perhaps he has also heard much of the troubles in getting it to work right. Nevertheless, the wonderful results obtained on "distance" by this circuit makes it popular. It is well known that tuned radio frequency amplification is much more efficient than the ordinary transformer-coupled method—but it is limited by "oscillation." This new method described here retains the extraordinary high amplification factor while at the same time it eliminates the possibility of oscillation.

By LAURENCE M. COCKADAY, R. E.

FOR summer reception there is no better method for receiving than the use of radio frequency amplification and a loop antenna—especially if the successive stages of amplification are tuned to the frequency of the incoming wave.

The reason is, that with a loop antenna, static is not picked up with such strength as it is with an ordinary antenna, and the loop tuning circuit has a low decrement when it is shunted by a condenser for tuning, whereas the ordinary receiving antenna may have a resistance ranging from 10 to 40 ohms at the broadcasting wavelengths. This means that the loop will tune much sharper and therefore, much of the static can be eliminated. The tuned circuits in each stage of radio frequency amplification also act as "traps" which let only the signals of a certain wavelength (to which they are tuned) through. In other words, these circuits seem to act as filters to static which seems to have no specific wavelength.

The set described in this article employs two stages of radio frequency

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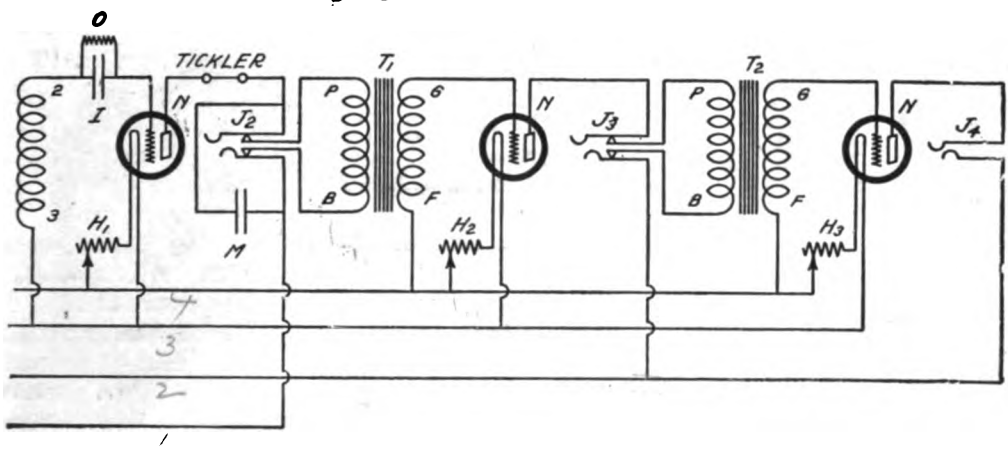

amplification and two stages of audio frequency amplification, with a vacuum tube detector. It can be used with a loop, with a short indoor antenna or with any type of outdoor antenna. The range with the loop or indoor antenna as far as tested up to the present writing seems to be about 1,000 miles. The range with the outdoor antenna has not been ascertained as yet but stations 3,000 miles away have been logged with a loudspeaker with good volume.

When used with an antenna, the primary circuit is semi-aperiodic, as there are only a few turns of wire used (with taps). The primary circuit is conductively coupled to the secondary circuit which is tuned by means of a small variable condenser. When a loop is used it is plugged into a jack, for that purpose, which disconnects the coils from the circuit and switches the variable condenser across the loop so that the same condenser may be used for tuning the loop. Each stage of amplification is tuned to the frequency of the incoming wave by means of an ingenious vario-transformer, a development by Lester Jones, former radio aide of the Navy Department at Washington, D. C. This transformer tunes the output circuit of the tube to which it is connected, and also the input circuit of the next tube, in a single operation. It has an extra plate winding for inducing a neutralizing voltage on the grid of the preceding tube which, when used with the special compensating condenser, prevents oscillation in the circuits even when they are *exactly tuned*. When an ordinary radio frequency amplifier is exactly tuned the circuits will burst into oscillation and reception of voice signals is impossible; a stabilizer potentiometer is sometimes used to partly overcome this difficulty.

With the circuit described, however, a potentiometer is *not* necessary. By slightly unbalancing the circuits after a signal has been tuned in—this is done with the compensators—regeneration can be employed in the separate stages of amplification so that the signals may be built up to an enormous strength, even from distant stations.

There is also a provision made in the set for connecting a variometer in the plate circuit of the detector to make use of the heterodyne search method for picking up distant stations.

The set will not re-radiate.

The electrical circuit diagram is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below.

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From a photograph made for POPULAR RADIO

DRAWING UP THE SPECIFICATIONS FOR THE CIRCUIT

In order to insure rigid accuracy in these "How to Build" articles in POPULAR RADIO, *the technical editor and his staff of experts lay out the diagrams, from the actual set, and check and recheck the lists of parts used, the construction, the wiring and the operating hints until everyone is satisfied that the data is complete and correct.*

The list of parts here given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

A—coupler-coil consisting of 60 turns of No. 24 DSC copper wire wound on a composition tube, 4 inches in diameter. Taps are taken off at the 3rd, 6th, 8th, and 9th turns.
B and C—Telos vario-transformers, 180 to 510 meters;
D—Haynes variable condenser, .00025 mfd.;
E and F—Amsco variable compensating condensers and knobs;
G—Fada rheostat, 5 ohms;
H1, H2 and H3—Amsco rheostats, 50 ohms;
I—Dubilier micadon fixed condenser, .00025 mfd.;
J1, J2 and J3—Pacent jacks, double-circuit;
J4—Pacent jack, single-circuit;
K—Fada tube sockets;
L—Dubilier fixed condenser, .1 mfd.;
M—Westinghouse fixed condenser, .0015 mfd.;
N—UV 201-A or C-301-A tubes used throughout;
O—tubular grid leak, 2 megohms;
P—composition panel;
Q—sub-panel made of well-dried hardwood;
R—Tait 4-inch dials;
S—Tait 3-inch dials;
T1—Amertran audio frequency transformer;
T2—Jefferson large type transformer;
U—four-point switch;
V—cabinet;
W—composition connecting-block with brass supports;

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X—composition connecting-block with brass supports;
connecting wire;
binding posts, etc.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel P, (shown in Figures 2, 3, 4, 5 and 6).

First of all the panel should be cut to the correct size, 7 by 30 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 4.

The holes outlined here with a double circle should be countersunk so that the flathead machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next the sub-panel Q, should be cut to the correct size, 7 by 29 inches, and painted with a dark *insulating* paint, and fastened to the main panel P, with wood screws running through the face of the main panel and into the edge of the sub-panel. (See Figures 5 and 6.)

Then, the two vario-transformers B and C, should be mounted on the panel P, in their correct places as shown in Figures 2, 3 and 5. Four screws are used to mount each transformer. The large dials R, are then secured to the shafts of the instruments by tightening up the knobs.

Next mount the four rheostats G, H1, H2 and H3, in their respective places, two screws to each rheostat, and affix the knobs and pointers. (See Figures 2, 3, 5 and 6).

Now fasten the two compensator condensers E and F, to the panel and attach the two small dials which are fastened with set screws. (Figures 2, 3 and 6).

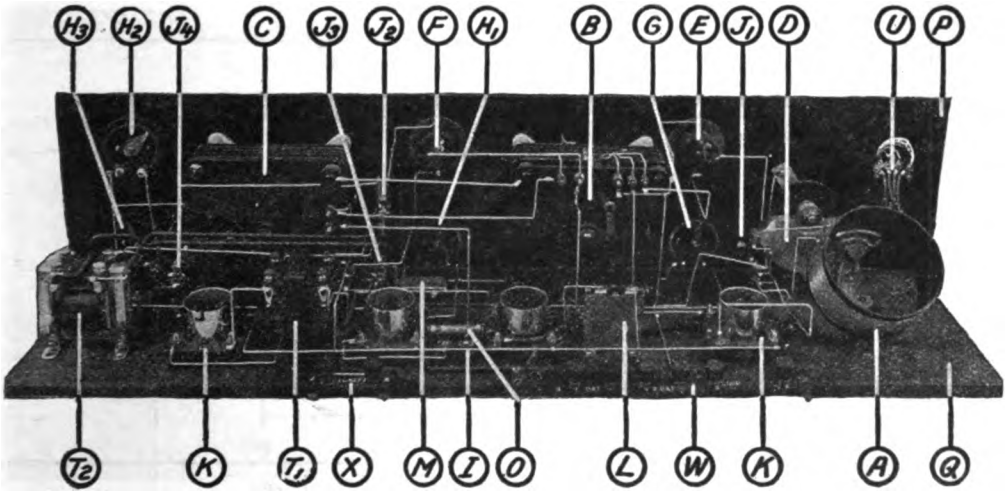
The switch and contact points U, should be installed on panel P, in front and slightly to the left of the coupler-coil A.

The variable condenser D, should be fastened in its place with three screws and equipped with the 3-inch dials S.

The coil A, should be mounted on the sub-panel Q, by means of a small bracket, as shown in Figure 6, or it may be fastened flat to the sub-panel in any manner that the builder may prefer.

Next mount the jacks J1, J2, J3, and J4, in their respective places in the holes drilled for them and shown in Figures 3 and 6. The fixed condensers I, L, and M, may be screwed to the sub-panel in the positions indicated in Figures 2 and 3.

The connecting-block W, and the tickler connecting block X, should be made of composition panel and equipped with brass supporting



AN INTERIOR VIEW OF THE RECEIVER

FIGURE 2: *This picture gives the general arrangement of the instruments as viewed from the rear and with the cabinet removed. For more specific details of construction the builder should refer to the diagrams in Figures 3, 5, and 6, which are mechanical drawings of the top and end views, and which are drawn to scale.*

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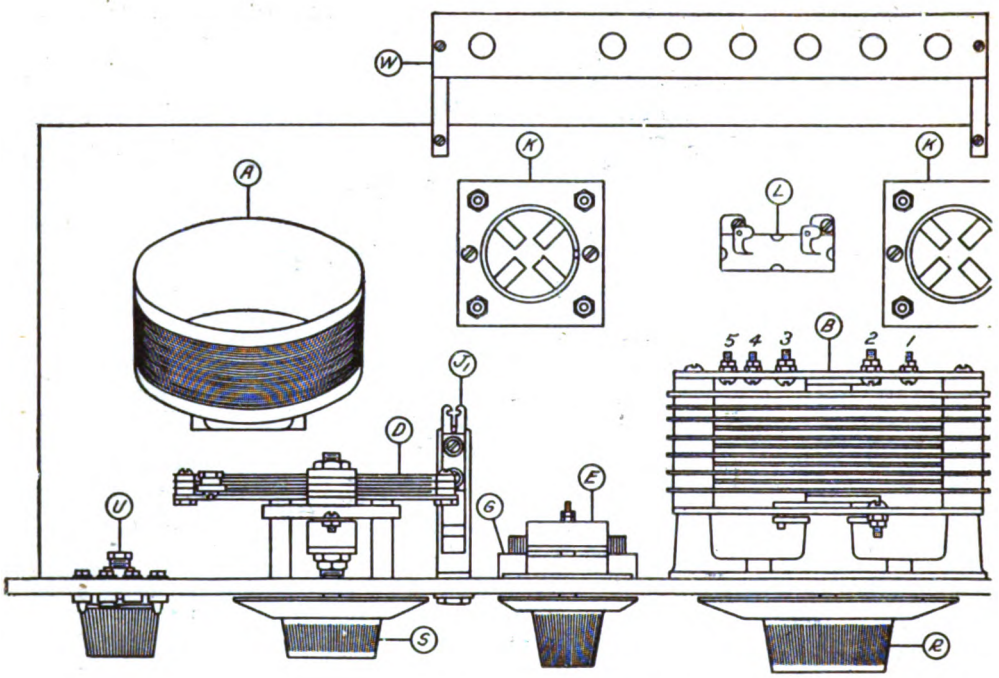
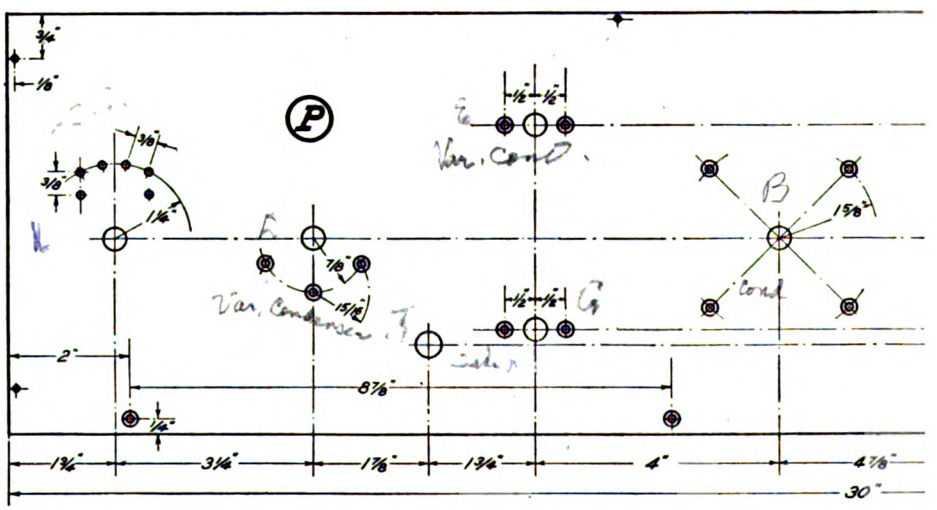


HOW TO PLACE THE INSTRUMENTS AND

FIGURE 3: *When building a radio receiving set from printed instructions it is usual for the amateur to use up some of the parts which he has on hand which he thinks "might do" as well. He is also accustomed to arrange the instruments as he sees fit. But our*



HOW TO PREPARE THE MAIN PANEL

FIGURE 4: *The locations for the centers of the holes are given vertically and horizontally, as well as the proper arc for the centers of the switch points. The correct sizes*

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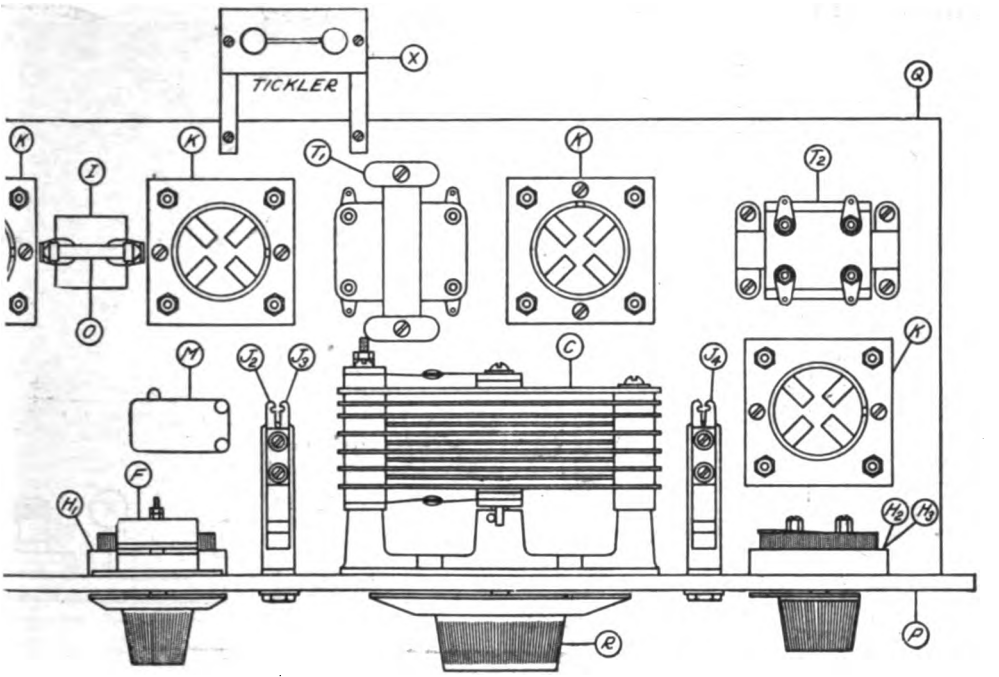
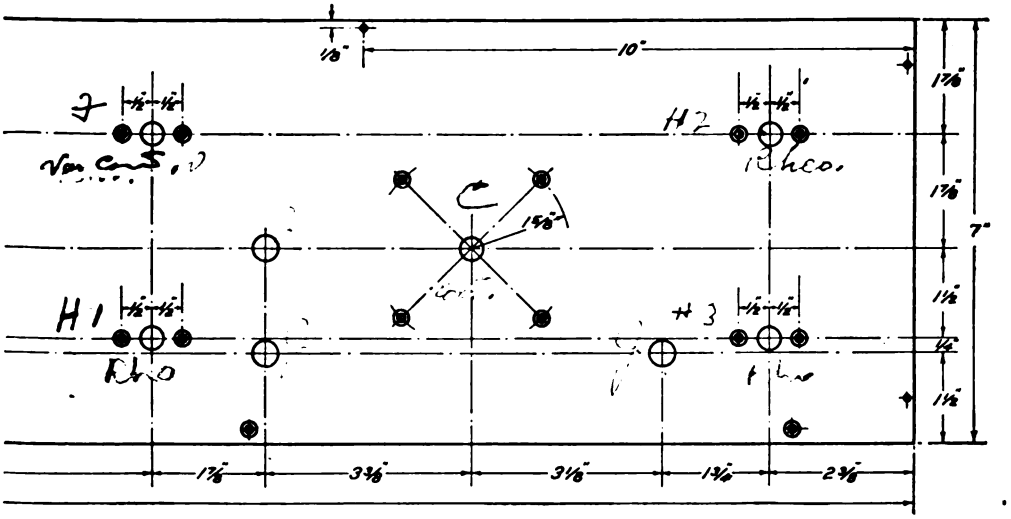


ASSEMBLE THE SET ON TWO PANELS

readers are advised to follow the arrangement shown above, at it has been carefully worked out.



AND WHERE TO DRILL HOLES

for the holes will be decided by the builder by observance of the diameter of the shafts of the instruments and the supporting screws that go through the panel.

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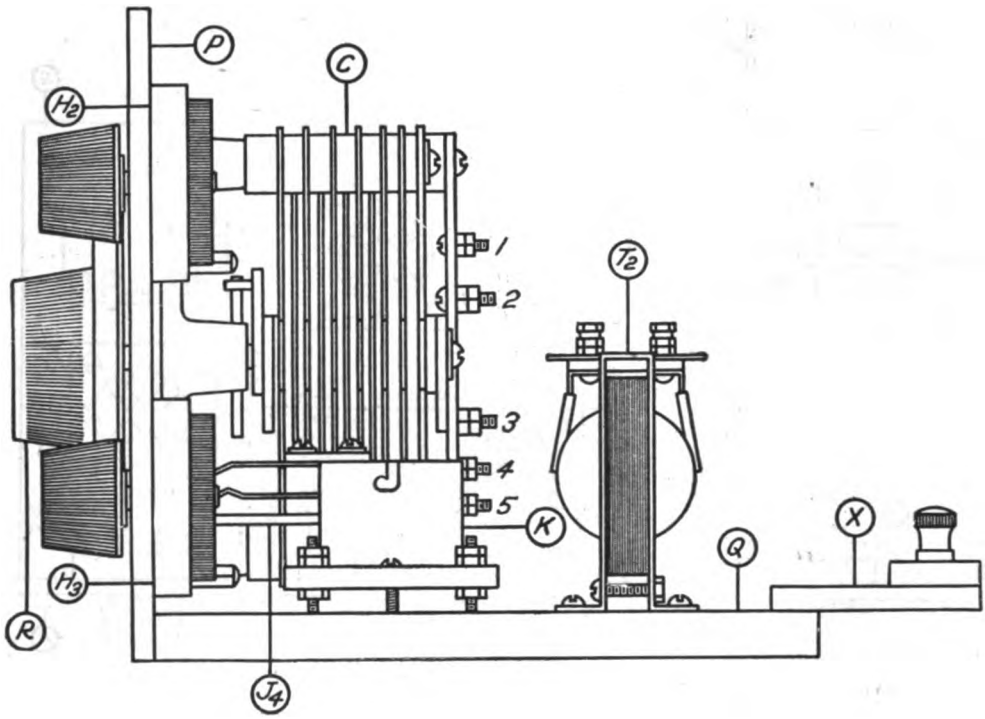

A VIEW OF THE SET FROM THE RIGHT

FIGURE 5: *This drawing shows clearly the method of mounting the vario-transformers, the transformers, the rheostats the socket, the jack and the tickler block.*

pieces. The blocks and the brass pieces should be of the dimensions given in Figure 8. When completed, the blocks should be fastened to the sub-panel Q, in the manner indicated in Figures 2, 3, 5, and 6.

The dimensions for the cabinet are given in Figure 7. It should be constructed of hard-wood and polished in any style preferred by the builder.

How to Wire the Set

The grid wiring of the set should be kept as short as possible and should be isolated from the other circuit wiring as far as possible.

Start wiring with the antenna and ground binding posts (the first two left-hand posts, looking from the front in Figure 3) and connect up the coupler-coil A, and condenser D, as shown in the diagram in Figure 1. The first jack is used to "cut out" the antenna and ground and the coupler coil, when a loop antenna is used.

Wire up the first tube circuit to the vario-transformer B, and the compensator condenser E, as shown in the diagram, and continue on with the second tube circuit including the second vario-transformer C, and the condenser F. The connections for the posts on the vario-transformer are indicated in Figure 9.

Now wire up the detector circuit and the two stages of audio frequency amplification as shown, including the transformers T1 and T2, the fixed condensers, and the other three sockets.

The "A" and "B" battery connections should be carefully traced through as well as the connections to the jacks to make sure that every connection is correct and that no circuits run foul of each other.

This will make sure that no tubes are destroyed when the circuit is put into operation.

A word of caution is here sounded against the use of excessive soldering paste on the jack connections and on and between terminals of condensers and other instruments. The paste contains acid and this causes leakage if allowed to remain between two connections. Only a very thin film of the paste is sufficient, and none should show on the insulation when the soldering is completed. If too much paste has been used by mistake, it should be removed by applying alcohol on a cloth; this will remove it readily.

Where the wires are fastened to binding posts and instrument terminals it is a good plan to use little copper tabs to which the wires can be soldered and then the tabs can be screwed down under the binding posts. Then if a mistake has been made in the wiring the posts can be loosened and the connection changed without leaving lumps of solder stuck all over the posts.

The third binding post from the left is the negative "A" battery, the fourth is for the

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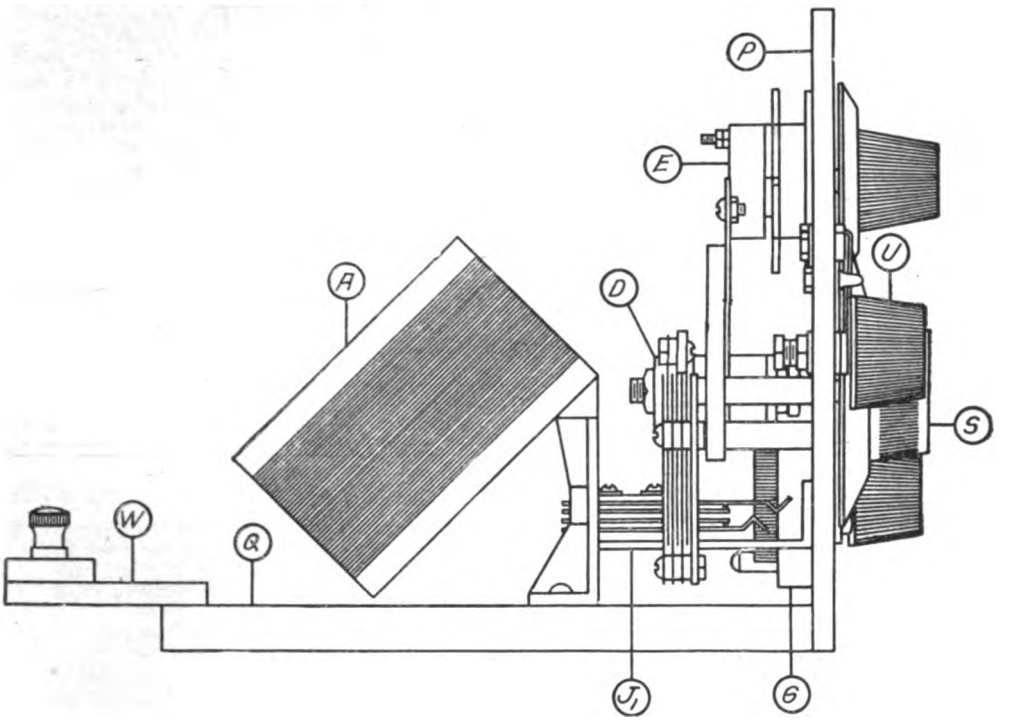

VIEW OF THE SET FROM THE LEFT

FIGURE 6: *This drawing shows how to mount the variable condenser, the coupler-coil, the compensator condensers, the jack, and the battery connecting block.*

positive "A" battery, the fifth the negative "B" battery, and the sixth and seventh are the detector plate 45-volt positive "B" battery tap, and the amplifier 90-volt "B" battery connection, respectively.

After you have finished the wiring job, sit down with some friend and check over the wiring once or twice before connecting up the batteries.

This will save you a lot of trouble in case you have made a mistake in the connections.

Operating Data

When using the set the following hints will be of practical value.

The set may be used with any antenna or "lighting plug" outfit, or it may be used with a loop antenna.

After the batteries are connected, the tube rheostats should be revolved in a clockwise direction until the tubes are all lighted to the correct brilliancy and the compensating condensers should be set at about 50.

The vario-transformer dials should be set at the proper wavelength, roughly, and the variable condenser tuned until the signal is picked up. Then the best tap on the antenna switch should be selected, and the finer tuning with the vario-transformer made. Then the compensator condensers should be adjusted for the maximum signal and the vario-transformers finally reset for the best results.

Amateur stations will tune between 0 and 40 on the vario-transformers, and low wave length broadcasting stations will tune somewhere between 40 and 65. The medium and high wavelength broadcasting stations will tune between 65 and 100 on the vario-transformer dials.

If an extremely loud signal is desired it would be advisable to connect a variometer between the tickler binding posts and this will be rotated when a signal has been tuned in to obtain regeneration in the detector circuit. If the variometer is not used the two tickler binding posts, which are in series with the plate circuit of the detector tube, should be connected together with a short piece of wire.

When used with the loop antenna the set is tuned in the same manner as with the outdoor or indoor antenna with the exception that the tapped switch is not used.

The set will tune from about 180 meters to 515 meters.

The range with an outdoor antenna should be several thousand miles and several hundred (upwards) with a loop, according to the kind of building the set is located in.

The loop is especially suitable for summer use, as it cuts down the reception of interfering static, so that the broadcasting from nearby stations at least is clear and enjoyable.

Tuning is extremely sharp on both the loop and the regular antenna.

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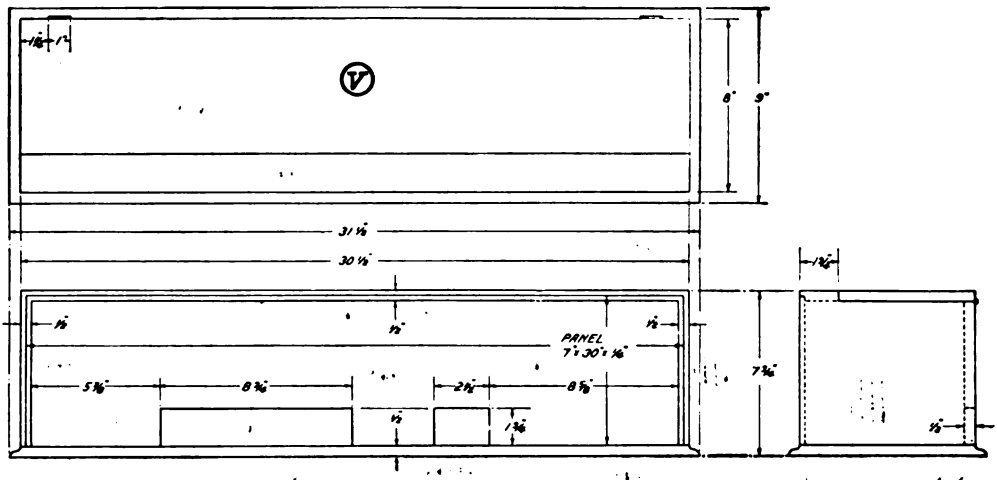
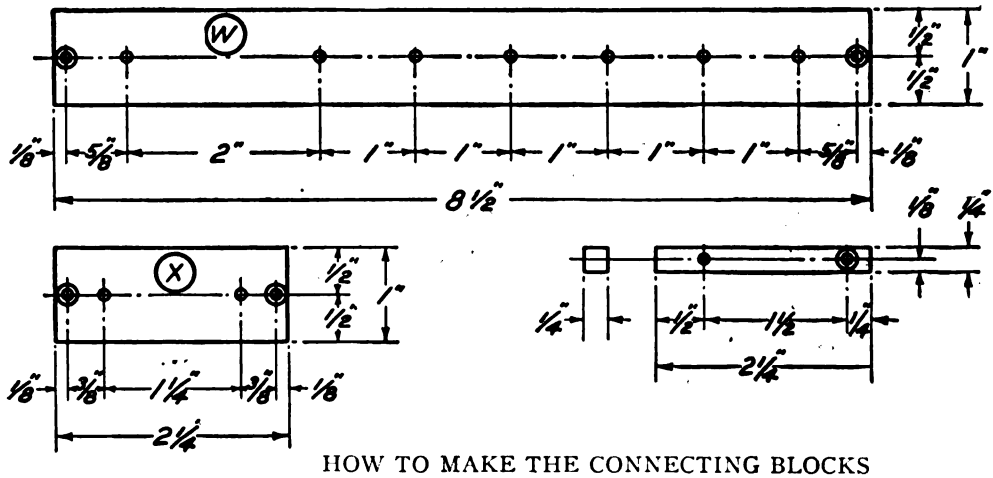


THE DIMENSIONS OF THE CABINET

FIGURE 7: *Notice that the front of the cabinet is partly cut away so that the panel P sets flush with the cabinet. There are two rectangular holes cut in the back of the cabinet through which will project the two connecting blocks, so that all connections may be easily made in the rear and no unsightly wires will appear in front of the set when it is in operation.*



HOW TO MAKE THE CONNECTING BLOCKS

FIGURE 8: *The sizes for the connecting blocks W and X and the brass supporting pieces. Two of the 2¼ inch brass pieces are used for mounting each block.*

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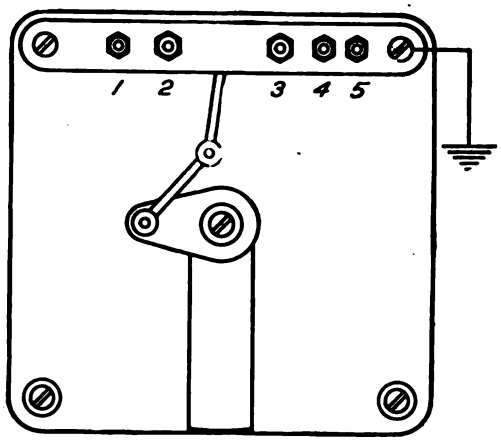
CONNECTION TERMINALS FOR THE VARIO-TRANSFORMERS

FIGURE 9: *No. 1 is the "B" battery tap, No. 2 goes to the grid, No. 3 goes to the negative "A" battery, and Nos. 4 and 5 are the plate and compensator connections. The aluminum frame of the transformer is grounded on one of the screws as shown.*



Kadel & Herbert

A NICKEL-IN-THE-SLOT RADIO SET

Parisian cafés, hotels and motion picture theaters are now being equipped with a device somewhat similar in outward appearance to a telephone pay-station apparatus that operates upon the insertion of a coin. Beside each instrument is hung a card on which the broadcast schedules are printed so that the pay-as-you-enter fan may know what to expect for his investment.

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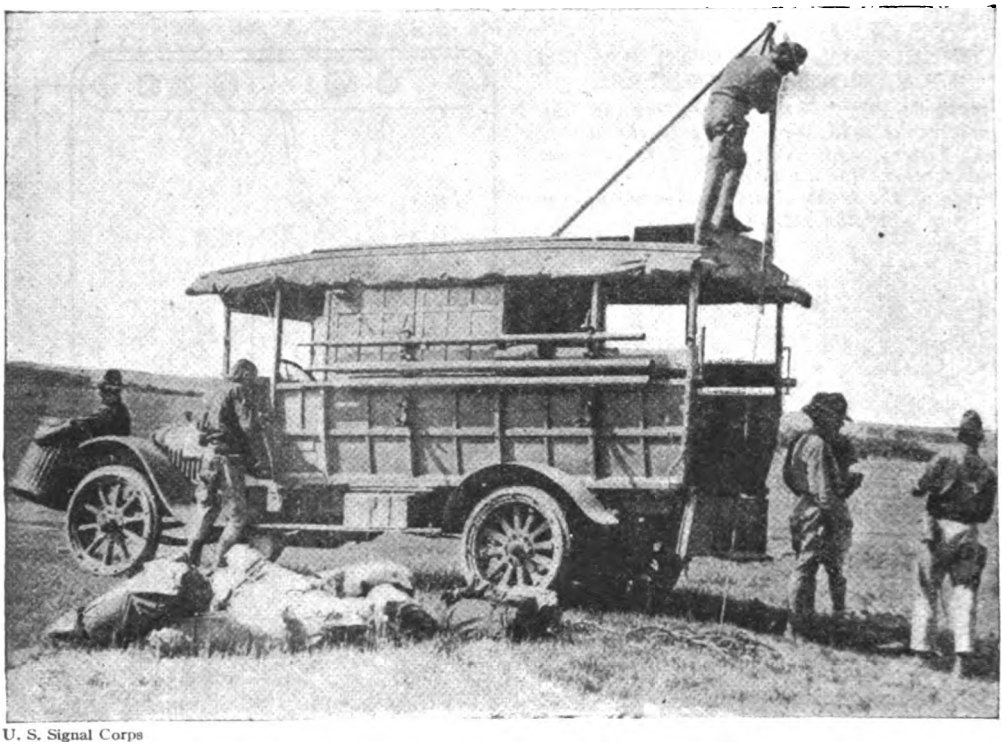

U. S. Signal Corps

A Radio Station on Wheels

By S. R. WINTERS

SPEED was a prime factor in the dash of the American troops into Mexico in 1914, in their pursuit of Villa and his bandit force. Good communication between the advancing columns and troop headquarters was another, for speed was dependent on the closeness with which these kept in touch with each other.

It is true that the army was equipped with radio apparatus for the purpose of communication, but the sets were carried by pack mules and could not be moved as fast as desired. Furthermore, the installation of a set, particularly the erecting of an antenna, took a lot of time. Radio could give neither quick nor effective service under these conditions.

The lack of results obtained in this emergency was the incentive upon which Brigadier General Edgar Russell set to work to improve the radio branch of the Signal Corps. The result was the first "radio tractor," similar to the one pictured on this page.

Today these mobile radio units have become essential to army operations; each of the nine areas in the continental United States, as well as divisional units in the Philippines, the Panama Canal Zone and other provinces, is to be supplied with an outfit.

The latest design, SCR (Signal Corps Radio) 97, is being built for the Government by the General Electric Company and mounted on speedy White trucks which can transport the station to any point with facility. The radio equipment proper is carried inside the car; the aerial mast is divided into sections and set in a rack on the side, as shown in the illustration on this page. What appears

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to be a trolley pole on top of the automobile is really an apparatus to aid in raising and lowering the mast. The actual setting up of these tractor aerials requires less than five minutes.

Recent tests, however, conducted by the Signal Corps have developed the fact that the portable aerial mast is not absolutely essential to the operation of the unit; any system of telegraph or electric light poles or even a tall tree may be used effectively as a support. The weight of the entire outfit, including the truck, is about five tons and thus the only real limitation to operation would be the necessity of staying on good roads or on fairly solid ground.

The above applies to the war-time use of the mobile radio station. To what purpose it will be put in peace-time is at present more or less a matter of conjecture. As a suggestion, in sections visited by tornadoes, earthquakes or prairie fires, communication might be maintained between the devastated areas and the outside world, in cases where all wires and stationary aerials were destroyed.

A SUBSTITUTE FOR THE ARMY MULE

Here the radio tractor is shown "set" for two-way communication. The antenna is in position, the counterpoise ground wires are spread out in fan formation on the earth's surface and the radio apparatus is tuned up ready for action. It takes just five minutes to accomplish this—including raising the antenna mast.

U. S. Signal Corps

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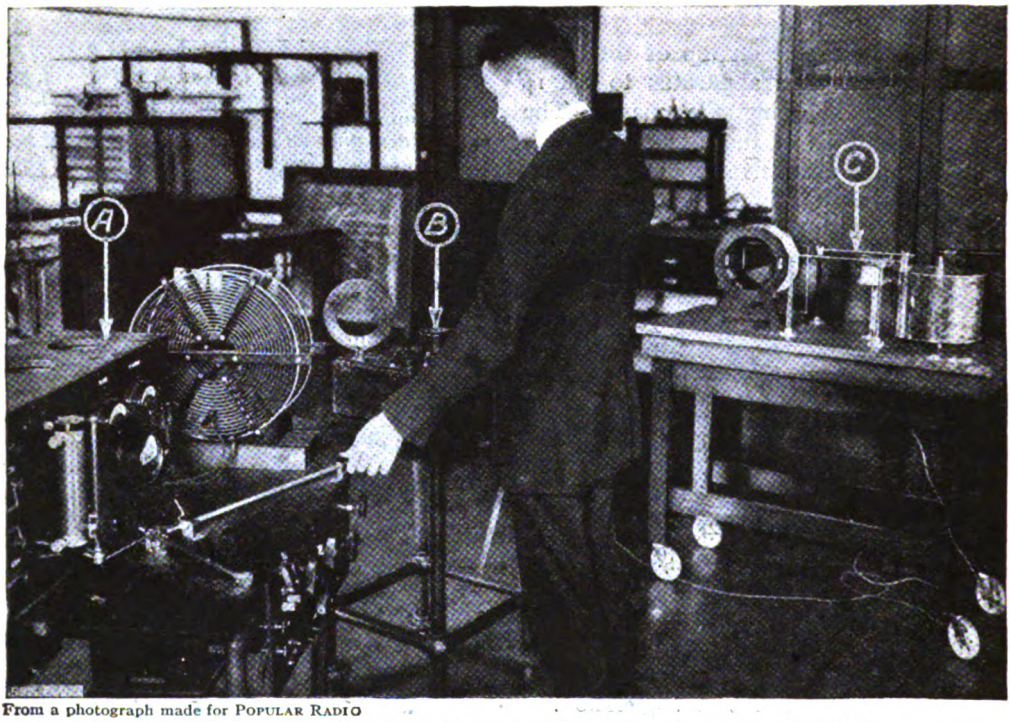

From a photograph made for POPULAR RADIO

TESTING A WAVEMETER IN THE LABORATORY OF THE BUREAU OF STANDARDS

FIGURE 1: *To calibrate an unknown wavemeter B, a high-frequency generator A, is used for generating a wave which is accurately measured by the standard wavemeter C. Then the unknown wavemeter B, is tuned to the frequency of the incoming wave and the setting of the instrument checked.*

How to Calibrate Your Wavemeter

To operate a transmitting station on the allotted wavelength is a problem that requires an accurate wavemeter for solution. How to calibrate this instrument correctly is here told by an expert of the Bureau of Standards, who has prepared this article for POPULAR RADIO by special permission of the Director.

By E. L. HALL

A WAVEMETER is one of the most essential instruments used in radio. Now that so many transmitting stations have been given wavelengths close together, the wavemeter assumes even greater importance than formerly.

As its name implies, the wavemeter is used to measure the wave emitted by a source of radio frequency oscillations. The most important point to know about this wave is its length—how far it is from the crest of one wave to that of the adjoining wave. This distance is called the wavelength. The wavelength is related directly to the frequency or number of waves or impulses a second, by the relation $\lambda = V/F$ where $\lambda =$ wavelength in meters, V=velocity of

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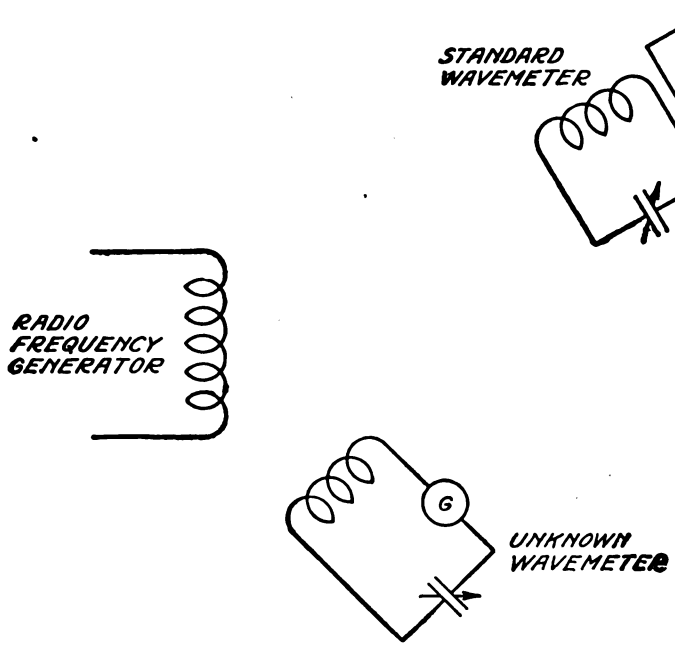
electro-magnetic waves (about $3x10^8$ meters a second) and F=frequency of electro-magnetic waves a second.

Radio frequency currents reverse the direction of their flow from (say) 10,000 to 30,000,000 times a second. Audio frequency currents reverse the direction of their flow from 16 to 10,000 or 15,000 times a second. It is possible to build a frequency indicator that will respond directly to each alternation up to 500 or 1,000 cycles a second, but beyond that other means for determining the frequency may be employed, such as comparing the audible note produced to that of a known source, such as a tuning fork.

When we consider radio frequency currents we see at once that some other method of determining the extremely rapid alternations is necessary. This is done by employment of the principle of resonance and by taking advantage of the large current which flows in a radio circuit that is in resonance with a "driving" circuit—that is, a circuit that emits waves or impulses of the same frequency.

Wavemeters may be of two types: receiving or transmitting. Both contain an inductance and a capacity. The inductance is usually made up of one or more interchangeable coils of different sizes, and the capacity is a variable air condenser.

The receiving type of wavemeter employs a means for indicating when the maximum current is flowing in the circuit. This is sometimes a visual means (such as a thermal galvanometer of some type, a small battery lamp or a vacuum tube filled with some inert gas like neon which glows when an electric discharge passes through it), or it may be an audible means, such as a crystal detector and telephone receiver.



HOW TO CALIBRATE A WAVEMETER BY MEANS OF A HIGH-FREQUENCY GENERATOR

FIGURE 2: *Here is a schematic diagram that illustrates the method of calibrating an unknown wavemeter by means of a high-frequency generator and a standard wavemeter as illustrated by the set-up shown in* FIGURE 1. *Resonance in this case is indicated by a galvanometer in the circuit of the unknown wavemeter.*

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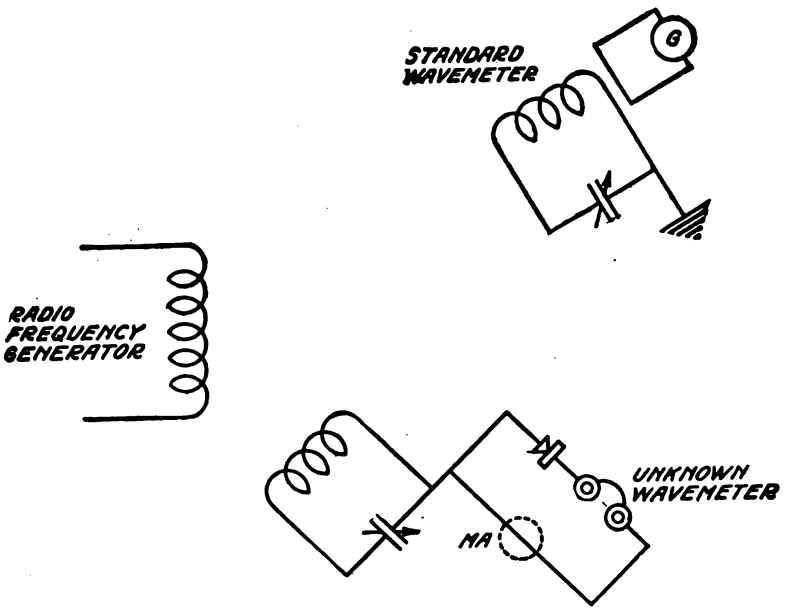

HOW TO CALIBRATE A WAVEMETER THAT HAS A UNI-LATERAL CONNECTION

FIGURE 3: *To calibrate an unknown wavemeter employing a uni-lateral connection either a crystal detector may be used or else a milliammeter, as indicated by the dotted circle.*

The transmitting type of wavemeter usually employs a battery-excited buzzer. The buzzer energizes the wavemeter circuit by impact, and the latter discharges, causing an oscillating current to flow in the wavemeter, the frequency of which is governed by the values of inductance and capacity in the electrical circuit.

There are several methods of connecting the various resonance indicators to the wavemeter; each has its own merits. The purpose of this article, however, is not to discuss the relative merits of the various connections, but to give a general idea of the method of calibrating a wavemeter.

The range of frequencies or wavelengths which a wavemeter will possess can be calculated readily beforehand, but an absolute calibration of the instrument can only be obtained by comparison with a wavemeter which has been calibrated or standardized.

The calibration of a wavemeter should not be considered to be exactly correct without regard to the time when the calibration was made. That this may be assumed was shown by a request received some time ago from a manufacturer of wavemeters, who asked for a copy of the calibration of a certain wavemeter. Upon looking up the data for this wavemeter it was found that the calibration had been made six or eight years ago, so that it could not be depended upon after so long a time.

For accuracy, a wavemeter should be checked up at least once a year.

In calibrating a wavemeter the following apparatus is required: a radio frequency generator capable of emitting any desired frequency over the range of wavelengths covered by the wavemeter under test, a standard wavemeter which is calibrated in terms of frequency or wavelength, the wavemeter to be tested, and a sheet of paper upon which to take data.

Five or more points should be selected on the scale of the condenser of the

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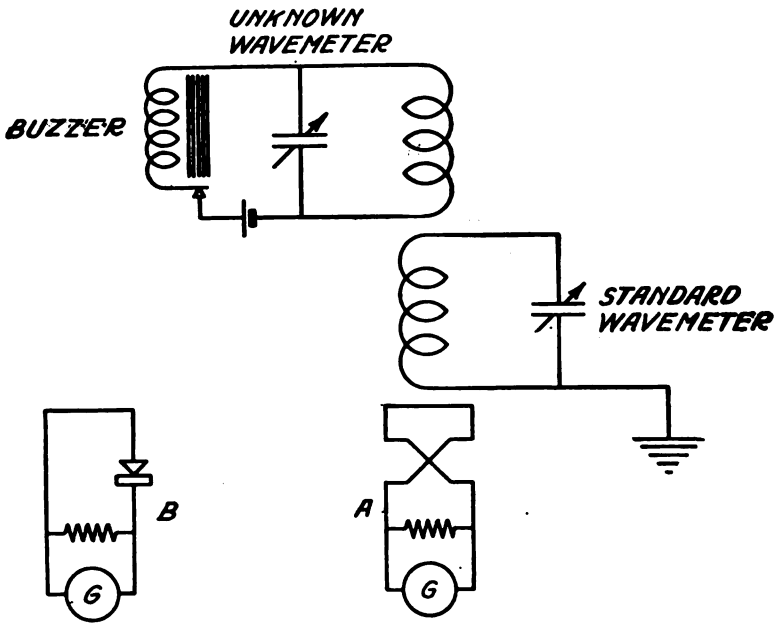

HOW TO CALIBRATE A WAVEMETER THAT EMPLOYS BUZZER EXCITATION

FIGURE 4: *In this case no external generator is necessary. The standard wavemeter is moved up close to the generator; sometimes extremely close proximity is necessary on account of the small amount of energy emitted by the buzzer. The settings on the scales of the two instruments are then compared and the unknown meter is corrected to correspond to the standard.*

wavemeter under test, at which tests are to be made. In selecting these points the extremes of the scale should be avoided. The lower ten degrees on the scale should not be used (except in extreme cases to obtain an overlap between two coils). This lower portion is avoided because of the small capacity in the wavemeter circuit in this region and the proportionally larger liability of introducing errors by reason of the proximity of other objects. The upper limit of the scale should be avoided because of the chance of error in the resulting calibration curve in case the scale is not set exactly correct with respect to the condenser plates.

In starting the calibration, the condenser of the wavemeter to be tested is set at the first point and the radio frequency generator is varied until resonance is indicated by the indicating instrument of the wavemeter. The condenser of the latter should then be varied slightly in each direction to determine whether true resonance has been obtained.

At times it is possible to appear to have reached the resonance point by tuning the generator to the wavemeter, but if the wavemeter condenser is varied somewhat it may be found that resonance is obtained somewhat away from the desired point. This may be caused by a reaction of the wavemeter upon the generator owing to too close coupling between the two, or it may be due to the capacity existing between the wavemeter and the operator's body. If a wavemeter is properly shielded this latter difficulty will not be observed, except perhaps near the minimum setting of the condenser.

A wavemeter, whether used for measurement purposes or in calibrating, should be coupled as loosely as possible to the source of power. If the wavemeter is coupled too closely to the generator it will react upon the generator. This condition is more likely to occur on coils of large inductance which have a

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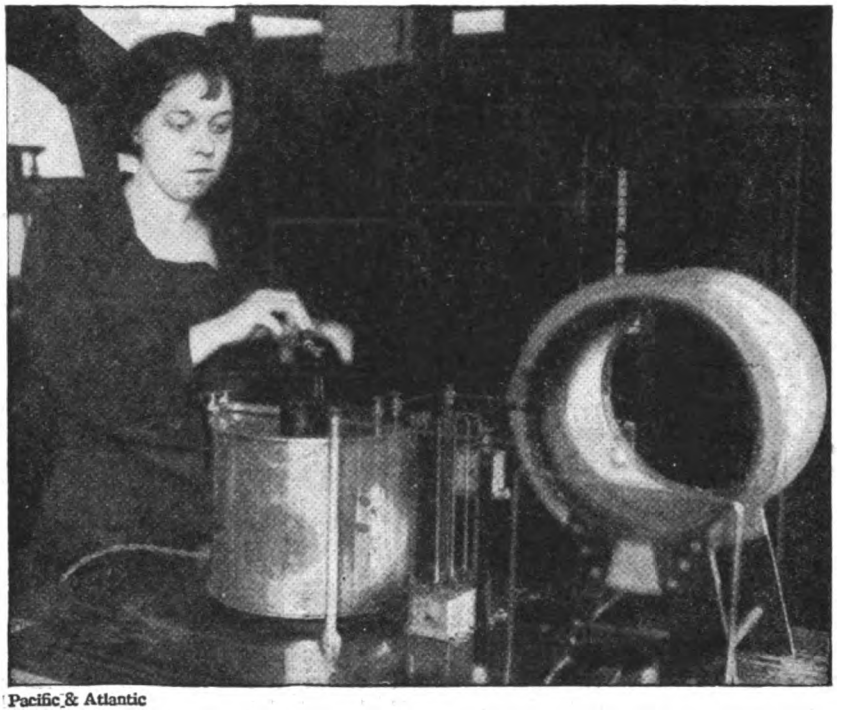

Pacific & Atlantic

A "PRECISION WAVEMETER"

The Bureau of Standards has done some wonderful development work in designing and constructing standards of measurement. These standards include instruments for exact measurement of length, weight, velocity, pitch, and intensity in practically all fields where measurement can be made.

large distributed capacity and a high resistance. It may be observed on the wavemeter by obtaining two *apparent* resonance points, by turning the condenser in opposite directions. These two points may be a fraction of a degree to several degrees apart. The only thing to be done in such cases is to move the wavemeter away from the generator (loosen the coupling) until but one point is observed.

Another reason for keeping the coupling fairly loose when calibrating the wavemeter is because the power that exists in harmonics of the fundamental frequency may be picked up instead of the fundamental frequency. A radio frequency generator does not have its entire power output at one frequency; it is distributed upon several frequencies which bear certain relations to the fundamental frequency or that obtained from calculations of the inductance and capacity in the circuit. The fundamental frequency has the greater part of the power, but the harmonics may have sufficient power to operate a sensitive detector. Usually no difficulty is experienced from tuning to harmonics when a hot-wire ammeter or thermogalvanometer is used as the resonance indicator.

After the generator is accurately tuned to the wavemeter at the point desired, the wavemeter is detuned and moved away from the generator and the standard wavemeter is brought up and tuned to the generator. The condenser setting of the standard wavemeter is then read and is entered on the data sheet opposite the proper condenser setting of the wavemeter under test. The identification numbers of all apparatus used should be kept so that errors will be avoided in computing results.

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The standard wavemeter is next detuned and moved away from the generator and the first one brought up and the generator tuned to the second point. All points throughout the series of coils are obtained in a similar manner. After the first complete test is finished it is repeated and the average of the two values for a given point is taken, unless there is too much of a difference between the values. In such a case a third reading is taken at the doubtful point, and it is likely that two of the three readings will agree sufficiently well. Errors in measurement or calculation are sometimes apparent when the calibration curve is drawn, because one or more points fail to lie on a smooth curve joining the majority of the determined points. The frequency or wavelength for other settings of the condenser than those at which tests are made can be obtained by reference to the calibration curve.

The calibration of a wavemeter that uses a crystal detector and telephone receivers as a resonance indicator is made in the same manner. If an electron tube radio frequency generator is used, undamped waves are produced and a means of modulation must be provided to produce a response in the telephone receivers, such as applying an alternating potential to the grid circuit of the generator. It will often be found that the resonance point is quite broad and that it is difficult to determine the exact point of resonance. Sometimes when the unilateral connection of the detector and telephone receivers is used a sensitive direct current milliammeter may be connected in the circuit (as shown by the dotted circle in Figure 3) without appreciably altering the resonance point. Then it is possible to obtain a sharp indication of resonance.

Before this method is used, the wavemeter should be tried out both ways to determine if the probable error in using the milliammeter is negligible. If the difference in resonance points by the two methods is significant, the milliammeter should *not* be used.

When calibrating a buzzer-excited wavemeter, the condenser of the latter is set at the desired point and the buzzer started. The standard wavemeter is brought up and tuned to resonance with the buzzer wavemeter. Difficulties are often encountered here owing to the extremely small amount of power emitted by the buzzer wavemeter. Extremely close coupling between the two wavemeters is often necessary. The resonance indicator of the standard wavemeter may be a thermo-element instrument of the crossed-wire type, with a couple of turns of wire connected to two terminals and coupled to the inductance coil of the standard wavemeter, and the other two terminals connected to a galvanometer, as shown at (a) in Figure 4.

Another indicator that is suitable consists of a coil of a couple of turns, a sensitive crystal detector and a wall galvanometer, all connected in series as shown at (b) in Figure 4.

Thus it is evident that in calibrating a wavemeter, whether of the receiving or the transmitting type, it is necessary to have a radio frequency current with a frequency or wavelength that corresponds to that of the wavemeter under test for the particular setting under consideration. This frequency will be determined by means of the resonance indicator of the calibrated wavemeter.

Wavemeters should be checked up with an accurately calibrated wavemeter at least once a year to be certain that the calibration has not changed.

"Testing the Einstein Theory with a Topaz"

That, in effect, is the purpose of the highly interesting experiments that are being made by Dr. Paul R. Heyl, who is using some of the most sensitive weighing devices ever made by man. Described in POPULAR RADIO *for September.*

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U. S. Dept. of Agriculture

¶ *The daily contact between the farmer and the Department of Agriculture officials is doing much to insure better distribution of better produce—to the advantage of the* ***farmer and the consumer alike.***

Radio—the New Farm Hand

By HARRY A. MOUNT

ONCE I spent two weeks on a farm. It was in mid-winter and in one of the most thickly populated states of the middle west, yet this farm was eight miles from the nearest town and a mile from the nearest neighbor.

But it was a modern farm. Horses were still used in the fields, but there was not a buggy in sight; instead there was a garage with two automobiles. The nearest picture-show was eight miles away, but that was only a few minutes away by motor. And although the nearest neighbor was a mile away, in reality the whole countryside lived closer together than the inhabitants of a Harlem flat, thanks to the busiest telephone system I have ever seen.

Literature? The mail man brought a great bundle of city newspapers and of come-on letters from the mail order houses every day.

Conveniences? A little gasoline engine in the wood-shed puffed away and furnished electric lights, and there was a tank in the cellar with water under pressure for the bathroom and kitchen.

The prospect of spending a week-end on such a farm as this, even in mid-winter, was not unpleasant, but—

No sooner had I arrived than it began to snow. It snowed all day and all night. The next day it snowed. Then it rained enough to put a crust of ice over everything and incidentally to pull down all the telephone wires. After that it snowed. Finally, on the morning

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From a photograph made for POPULAR RADIO

¶ *The head of the government's radio service to farmers, Mr. J. C. Gilbert, of the Radio Market News Service of the U. S. Department of Agriculture in Washington. This service now covers the entire country.*

To help the farmer plant, protect, harvest, pack, ship and sell his produce is the practical purpose of Uncle Sam in maintaining his Radio Service. Just how he does it is told in this article.

of the fourth day the sun came out on a world of marvelous beauty, if one had an eye for beauty, and marvelously depressing if one had an eye for business. We were snowbound, and there was nothing to do but wait until the snow melted or until some one from the outside dug through the drifted roads to us.

Things went along pretty well for a couple of days. By that time the subjects for conversation had narrowed down to one—the weather. Soon we all knew the contents of the last batch of mail order advertisements by heart. By the following Sunday I had finished the Sears Roebuck catalog and started on the Montgomery Ward catalog. At the end of ten days the whole household was on the verge of open hostilities, openly arrived at. I think it would have been a case of the survival of the fittest if a good old-fashioned slush-and-mud thaw hadn't set in then. By Sunday the roads were sufficiently cleared to reach the railroad station, and we only had to dig the car out of the mud twice on the way.

But that was away back in the year 1920 B.R.C. (Before Radio Came). A part of the modern equipment of that farm now is a radio set.

The other day I had a letter from one of those country cousins. Here is part of it:

We have scarcely been away from the farm, excepting for the necessary trips to town all winter. We would rather stay home and listen to the radio than traipse off eight miles to the

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Underwood & Underwood

BROADCASTING MARKET QUOTATIONS

The current prices of wheat, corn, oats and other farm produce are matters of real importance to the farmer. So the Chicago Board of Trade sends out the closing prices by radio every day. The above picture shows L. B. Mitchell, the announcer.

picture-show. We listened through a whole performance of the Chicago grand opera company last night, and after that we heard a quartet in Houston, Texas, so plainly that you could hear the bass singer catch his breath.

Charles has a new gag he pulls on the neighbors. Everyone has a radio now and when some one stops in the first thing that's said after the weather is disposed of is:

"Well, how's the radio?"

Then Charles pipes up and says,

"Why, we get Rhode Island so good we can hear the hens laying eggs!"

Well, it isn't quite that good but pretty nearly.

You know Mom has been selling her eggs to an old huckster that comes along here. He picks up a load, paying whatever he has to for them, and then ships to the cities. Of course, he is well posted on market prices up to the minute, but Mom has to depend on her bickering ability and she says that isn't very good or she never would have married a farmer. But even if Mom is a poor bargainer she can make hens lay eggs in winter and usually when everyone else is getting barely enough eggs for their own use, Mom has lots to sell. This old huckster knows that and he knows that Mom is soft so he always stops here. The other day he drove in and put on his long face as usual and told Mom that the egg market was bad and getting worse and that he fully expected to lose a lot of money on her eggs, but he always believed in treating his regular customers right, so he would give her a good price—and he named it.

"Well!" said Mom, "I've got quite a heap of eggs this time and I think I'll just ship them myself. The New York quotation on eggs this morning is just twenty-five cents a dozen over your offer."

If you ever saw a surprised man, it was he. His mouth dropped open like a trap door at a hanging and he just looked at Mom. Then he began to turn red and he got mad.

"What do you know about New York quotations for today?" he said to Mom.

"Why," replied Mom, cool as a cucumber, "we get the early morning quotations every day at eight o'clock from New York over the radio. Hereafter, you'll have to get around before that."

Well, the old goat began to see light, I guess, for he forced a grin back on his face, although the grin was rather a failure from an artistic viewpoint, and said:

"Well, if that's the market on fresh eggs, you shall have it. How many dozen have you?"

He paid for the eggs with the best grace he could muster, which wasn't very good. Just as he was driving out the front gate, Big Ben, our red rooster, stood on the gate post and crowed at him, just as if he were enjoying

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a little private revenge. The old codger made a slash at him with his whip, but Ben made a jump and he missed. But if that whip had ever caught Ben in the crowing member, I fear we should now be looking for his successor.

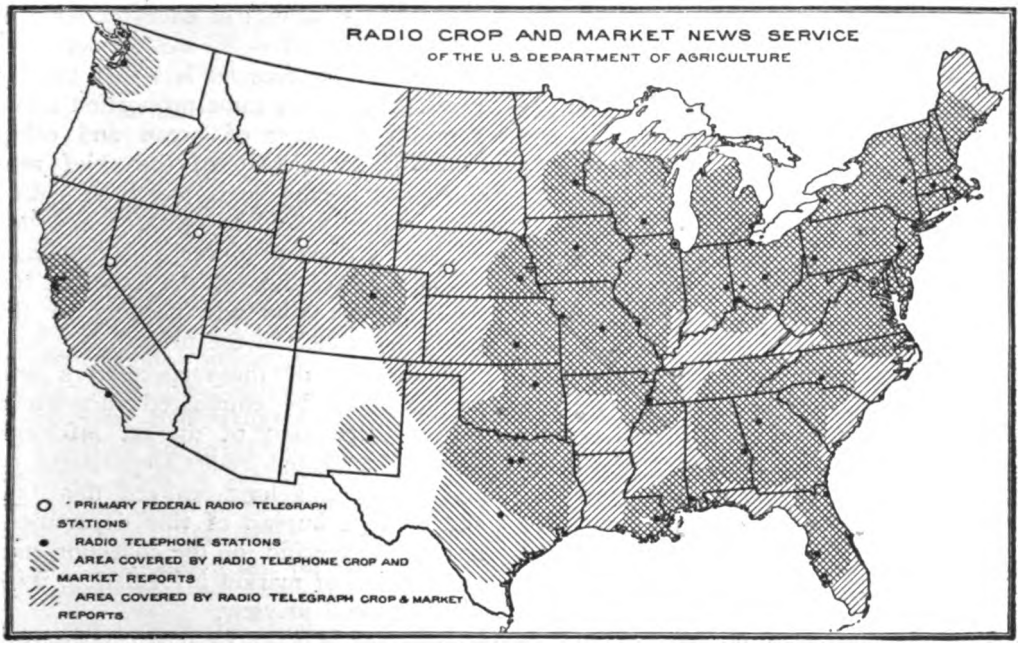
And, say, I almost forgot to tell you (we scarcely noticed it ourselves) we have just come through another blizzard and we have been snowbound for several days. But who cares, now! The worst blizzard that ever blew can't cut us off from the rest of the world. Charles has strung bell wire all over the attic and when anything goes wrong with the outside antenna we use that, and it is nearly as good.

And so I say that radio finds its most appreciative audience and its greatest practical usefulness out in the Great American Lonesome, where the only skyscrapers are the turkey buzzards wheeling about overhead. I think we will all be willing to admit, upon a little reflection, that the entertainment which radio affords probably is most heartily received where entertainment in any form is a rare treat. And in spite of the automobile and the telephone and all of the other equipment of a modern farm, life there remains a very drab sort of existence.

Last summer I went up into Massachusetts and spent some time in a section which once had supported a prosperous agricultural community, and which is now almost entirely abandoned. The land had not "run out." Farms which were still being worked are as productive as ever. It was the families that had "run out." Everywhere, to my question, "Why was this farm abandoned," I received a reply that became monotonous for its sameness:

"Well, the boys wouldn't stay on the farm and when the old folks couldn't manage alone any longer, they just quit and moved away."

Of course those farms are hilly and rocky and in the staple crops cannot compete with the newer flat farms to the west. But they have the very great advantage that they are close to the eastern market centers and they are also well fitted for sheep and poultry


RADIO CROP AND MARKET NEWS SERVICE
OF THE U. S. DEPARTMENT OF AGRICULTURE
PRIMARY FEDERAL RADIO TELEGRAPH STATIONS
RADIO TELEPHONE STATIONS
AREA COVERED BY RADIO TELEPHONE CROP AND MARKET REPORTS
AREA COVERED BY RADIO TELEGRAPH CROP & MARKET REPORTS

HOW UNCLE SAM REACHES THE FARMER BY RADIO

Practically the entire cultivated area of the United States is covered by the radio service. Since this map was prepared the number of broadcasting stations enlisted in this service has been increased.

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raising, dairying and the like. No, it was not an economic problem which caused this disaster, but the failure to solve a pressing human problem. The boys and girls raised on the farm preferred to its lonesomeness the bright lights and the companionship of the towns and cities.

Go into any farming community in the country today and you will hear that very same complaint: "The boys and girls won't stay on the farm." Permanent farm labor is hard to get for the same reasons. Will not radio, by taking the best that the city has to offer of music and thought, to the farmer's own fireside, help to solve this very real problem?

I think it will.

I know it is doing so in some specific cases, for I have before me as I write copies of half a dozen letters written by farmers to one of the big Eastern radio stations, in testimony of that fact.

But if the radio is helpful in solving the big social problem on the farm, it has become well-nigh indispensable as an instrument of practical usefulness. Take the matter of weather reports. All of us are interested in the weather, but to the farmer the weather is the biggest single factor in the success or failure of his business.

With this thought the government has perfected a wonderfully effective organization for gathering data and making weather forecasts, and it utilizes every means for getting this information to those who are particularly interested. But there has been no way to get a weather report to the isolated farmer within less than thirty-six hours from the time the prediction is made.

Now, weather may be predicted for any given locality with great accuracy for the next twelve hours, but predictions made thirty-six hours or more ahead will of necessity be less useful. Storm warnings, frost warnings and the like can of course only be given to those who can be reached quickly.

Radio provides, for the first time, a means for reaching practically the whole country within an hour or two, and accordingly the effectiveness of the government weather service has suddenly been increased a hundred fold. Weather reports are as vital to the farmer as stock reports to the stock broker and if nothing else came in over his radio receiver, it would be more than worth while.

Market reports are of scarcely less importance to the farmer. If there is anything more changeable and uncertain than the weather, it is markets. At nine o'clock in the morning, market reports on certain commodities are the livest of live news. At six o'clock in the afternoon they are ancient history. That is why the farmer, who has had no means of getting market reports up to the minute, has been at the mercy of the food speculator.

The farmer's complaint that he receives too little of the consumer's dollar is not entirely without foundation. To cite an example: of every dollar you spend for rolled oats, the farmer who grew the grain receives less than twenty cents. About the same proportion holds good in the case of bread and other grain products. One of the chief reasons that twenty cents worth of rolled oats is finally sold to you for a dollar is that between producer and consumer the oats passes through the hands of too many people who add nothing to the value, but much to the price.

A number of these speculators will automatically be eliminated through a better distribution of market information. The United States Department of Agriculture has long realized this fact and a large bureau of this department has for its specific job the collection and distribution of market information, with this very end in view.

The collection of market information is, and has been for a long time, remarkably efficient. The Department of Agriculture maintains an extensive leased

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From a photograph made for POPULAR RADIO

DAILY TIPS TO THE FARMERS OF THE WEST

Just where and when to market his products is a problem that always confronts the farmer. The Kansas City Board of Trade is helping him solve it by broadcasting up-to-the-hour prices every day.

wire telegraph system direct to the important large market centers, such as New York, Chicago, Kansas City, and St. Louis and all of these telegraph wires terminate in a room in one of the department buildings in Washington. Through this means hourly reports are received, and frequently during the day bulletins are prepared for the press and other agencies for distribution. In addition, daily and weekly as well as monthly and yearly market reviews are prepared and given the widest possible distribution.

All this is of value, but the market news of most value is that which reaches the man who wants to use it within a few minutes, or at most within an hour or two, after it is "news."

That is where radio comes in. It has tremendously increased the effectiveness of the market news service.

At first, when there were not so many radio receiving sets on the farms, an attempt was made to broadcast the information by sending it in code from government, army, navy and post office radio stations. To receive it a corps of volunteer radio amateurs was recruited who were to listen in at various times during the day and then to make the information they received available to their neighbors, country newspapers, granges, county agricultural agents, and the like. But the boys did not always finish their sessions at the old swimming-hole in time to receive the reports and the experiment was not very successful.

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Only a little over a year ago the first market reports were broadcast by radiophone. As this is written ten government-owned and 76 private stations are broadcasting crop and market reports furnished by the Department of Agriculture and this so effectively fills the need that broadcasting in code has just been discontinued entirely.

In a few cases, especially in the East, market reports of local interest are furnished by State Departments of Agriculture to the broadcasting stations.

Recently Mr. J. C. Gilbert, who is in charge of this new activity of the Department of Agriculture, broadcast the request that farmers and others who were using the service write to him and tell him what specific uses were being made of it. Hundreds of letters poured in and an analysis showed that about half of them came from individual farmers, and the remainder from grain dealers, mills, elevators, banks, telephone companies, co-operative organizations, farm bureaus and other agencies which disseminate the reports among large groups of farmers.

The greater number of replies came from the Middle West. Missouri, Illinois and Iowa led in the number of responses to the inquiry. The letters indicate that nearly every farm in those states is radio-equipped with receivers that average about $85 in cost.

"A great many of the farmers," said Mr. Gilbert, "gave specific instances of savings resulting to them from the radio market reports. One farmer said he regarded the radio as the direct gift of God. Numerous general stores and banks in the small towns say their places of business have become headquarters for market news information, and a great increase in their own business results.

"At the present time the whole thing is in a formative state and it is difficult to say just how it will end up, but I think the need and demand for this sort of broadcasting has been fully established. Some of the stations which have been broadcasting market news are giving it up and we are adding others in their places. At present any farmer living east of the Mississippi or west of the Rockies is pretty sure to be within convenient distance of a good broadcasting station which two or three times during the day sends out our reports. The region between the Mississippi and the Rockies is not so well served, but we are gradually filling in that gap and we hope before long to place our radio service within reach of every farmer in the United States."

More power to Gilbert and his radio for Reuben!

How radio is being used for alleviating human suffering will be told by Mrs. Christine Frederick in a coming issue of POPULAR RADIO.

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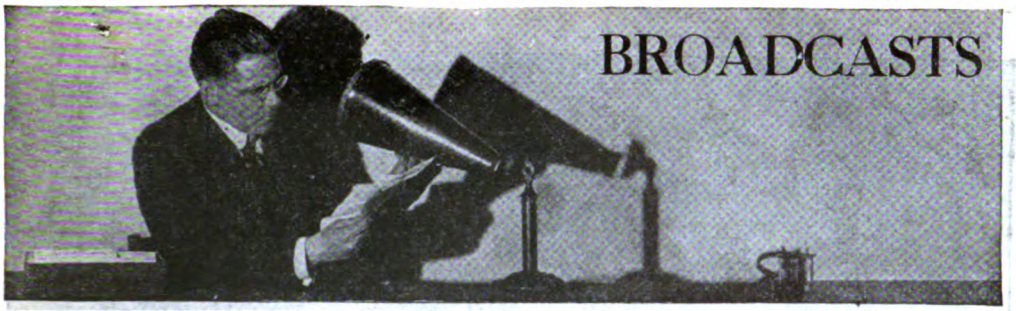

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

A Chance Knowledge of Radio Saves 33 Lives at Sea.

WHEN seaman Addison Galligan, who is an ardent radio fan, picked up a little knowledge of the Morse code, he did it for his own amusement and with no idea that it would be the means of saving the lives of a whole ship's company at sea. But when the *S. S. Nika* caught fire off the coast of Washington, he was the only man on board who knew even a little code. Haltingly he spelled out "SOS," and then "f-i-r-e." The coastguard cutter *Snohomish* picked up the call and rushed to the *Nika's* aid in time to rescue everyone on board.

* * *

Over 250 Licensed Amateurs a Month

LEST some fans believe that the reception of broadcasts is the only popular phase of the radio art, be it known that amateurs are still entering the game of "key pounding" at the rate of over 250 a month. Since January 1, 1,334 amateur licenses have been granted by the Department of Commerce, and on June 5, there were 18,232 such stations in the United States.

The distribution of amateur stations by Districts on June 5th, was as follows:

District	*Headquarters*	*Total*
1	Boston	2,490
2	New York	2,629
3	Baltimore	1,994
4	Norfolk	444
5	New Orleans	941
6	San Francisco	2,172
7	Seattle	901
8	Detroit	2,932
9	Chicago	3,729
Total		18,232

The above table does not include special amateurs, of which class there are 201.

* * *

Radiophone Service from Ship to Shore

THE United Steamship Company of Copenhagen, Denmark, plans to install radio telephone equipment on all boats plying between Copenhagen and the provincial harbors for the traveling public's convenience. Travelers will be able to secure direct communication through the land telephone service, with their own homes or offices.

* * *

Beer—or Radio?

A DECISION was handed down recently by an English court which declares that it is illegal for a public house (English for what we used to call a "saloon") to furnish their patrons with both liquid refreshment and radio music. From now on, evidently, the customers will have to choose between broadcasting and beer.

* * *

The Radio Information that the Farmers Want

A CANVASS made by the Department of Agriculture in regard to its broadcasting of market news reports indicated that the grain reports were most popular, with livestock reports and weather reports next in order.

* * *

A Silent Period for Amateur Transmitters

AT the suggestion of the amateurs themselves, who generously wish to co-operate with broadcast listeners all over the country, the government has issued an order which requires that all amateur stations keep off the ether from 7.30 until 10.00 P. M. All new amateur licenses will contain a clause which definitely restricts operators from encroaching on the ether during these hours.

* * *

A Chance for Amateurs to Visit the North Pole—by Radio

WHEN Donald B. MacMillan, the noted explorer, leaves Booth Bay, Maine, this summer for his seventh dash toward the pole, he will take with him a complete radio outfit and an amateur operator provided by the American Radio Relay League. By doing this it is expected that he will eliminate the loneliness that usually goes with such an expedition for he will probably be able to keep in touch with civilization until he is within twelve degrees of the Pole. Incidently, amateur radio will benefit, as the operator chosen will send in a weekly log of the amateur stations that he hears while he is in the Arctic Zone.

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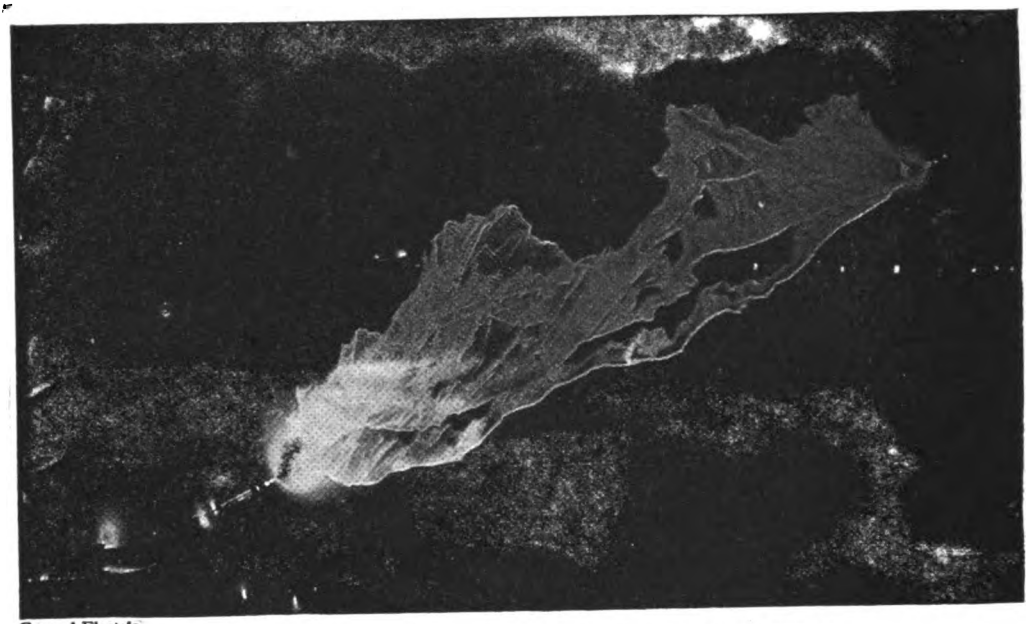

General Electric

THE MOST DANGEROUS LIGHTNING BOLT EVER FORGED BY MAN

This writhing shaft of electrical power, twenty-five feet long, has such tremendous force that in demonstration it not only shatters but practically eliminates a block of wood of 16 cubic feet. The flash pictured above was generated between the testing electrodes of 2,000,000-volt transformers—which are the highest voltage transformers in the world.

Will Radio Create a New Department of Government?

INTEREST in radio throughout the country is responsible for the fact that in a report for the reorganization of the government the only substantial change suggested was that the Post Office Department be renamed the "Department of Communications," and that it be provided with a bureau "to develop and extend telephone and telegraph service, particularly radio, throughout the country."

* * *

885 Radio Stations Operated by Uncle Sam

A RECENT report shows that there are at present 885 radio stations operated by the U. S. government. Of these the Navy has 533 ship and 52 land stations and the Army has 180 land stations. The rest are operated by the Post Office, Commerce, Interior and Treasury departments.

* * *

Radio Music that Comes by Telephone

WHAT appears at first to be an application of the recently-developed principles of "wired wireless" is now in effect in Backus, Minnesota. As a matter of fact, it is not "wired wireless" at all, but an ingenious device of the local telephone company. The loudspeaker of a receiving set located at the central office is placed in front of a transmitter which is connected to a farm line; the patrons of the line are thus enabled to listen in on broadcast programs even if they have no apparatus of their own.

* * *

How a Radio Theory Worked Out in a Transatlantic Test

AN interesting example of how radio theories work out practically was afforded by the tests in transatlantic transmission which were recently carried out on signals from the station at Rocky Point, Long Island. The electric field strength which the signals should have when they had reached London was calculated in advance by means of the Austin-Cohen formula. Then the incoming signals were actually measured, and were found to have substantially this strength. This is only one case of many where this famous formula has worked out satisfactorily in practice.

* * *

Radio Carries to Mother Applause Given Her Son

WHEN the French consul Gaston Liebert conferred the Cross of the Legion of Honor upon Barre Ferre at the annual banquet of the Pennsylvania Society at the Waldorf-Astoria in New York, one of those who heard the applause was his mother, Mrs. S. P. Ferre, who was in Rosemont, Pa., where she listened in on the banquet by radio and heard her son receive his honor. Radio broadcasting is becoming a matter of public service.

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A Record Long-Distance Reception

A RADIO message from the Naval station at Cavite, P. I., addressed to San Francisco for relay to Washington was picked up in the Washington Radio Central recently and copied before the San Francisco operator indicated its receipt. Needless to say, it was not relayed to Washington. This message was copied without error over 11,500 miles of sea and land.

* * *

The Legal Status of an Aerial on a Roof

ACCORDING to a recent decision by a Chicago magistrate, a landlord cannot legally destroy his tenant's radio aerial, inasmuch as the radio set is "an appurtenance to the home."

* * *

Radio in the Waiting Room

CALLERS upon Mayor Hylan of New York are not at a loss for entertainment even while waiting to be ushered into the sanctum, for a radio set has been installed in the reception room at City Hall. "It will be a welcome diversion for humble citizens who come daily and kick their heels while sitting on the benches in the lobby or in the reception room waiting to see the executive," observes one newspaper. "It is understood that a connection has been made with the Mayor's private office so that he can switch on a concert now and then to break the strain of his working hours."

* * *

The Charlie Chaplin of Radio

"The best known man in France today, not excluding President Millerand, is M. Radiolo, the official announcer of France's single wireless broadcasting firm," states *The Sun*, New York. "Six months ago he was discovered working in a railroad accountant's office. Manufacturers of a wireless apparatus offered him a contract at a salary of 1,000 francs a week to talk into the transmitter for three hours daily, his voice being considered to have a greater resonance than that of either Caruso or Jean de Rezke at the height of their careers.

"But Radiolo is finding his fame irksome, as he can no longer attend theaters without having the audience rise and applaud just as if he were the President entering the official loge.

"The performance at a suburban theater was stopped in the middle of the first act last week until Radiolo, who had entered, satisfied the radio fans by repeating without a smile the phrase which introduces all French wireless programs: *Bon soir, mesdames, bon soir, messieurs.*"

* * *

Broadcasting in Japan

ALTHOUGH radio enthusiasts in Japan do not have all the advantages of their brother fans in the United States, from now on they will at least be able to enjoy regular broadcasting. The Japanese government has realized the wisdom of relaxing its rigid policy and has licensed a number of firms to broadcast music, speeches, and government reports. This service will be paid for by a fee which will be collected by the government and handed over to the companies.

* * *

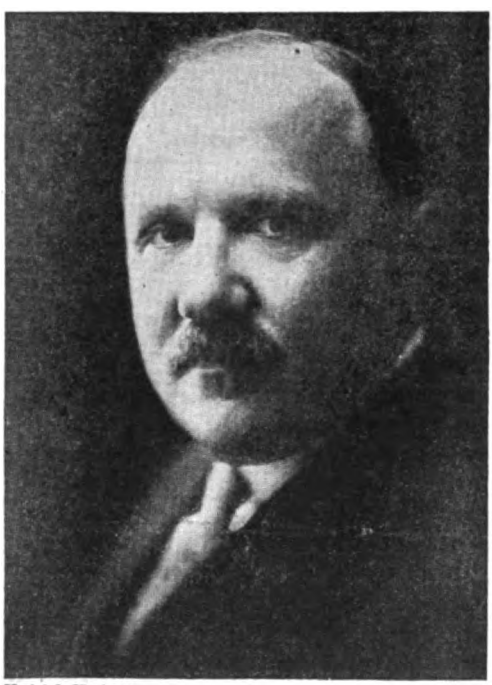
Learning Languages by the Ether Method

ONE of the most important factors in learning a new language is to have plenty of practice in hearing it spoken. A broadcasting station located in Sheffield, England, has realized this and is making an experiment in sending out French lessons by radio. As a matter of fact all that the European radio fan who wishes to learn a new language need do is to pick his headphones, tune in some broadcasting station of a foreign country, and listen in.

* * *

First Aid to a Ship's Engine by Radio

AN unusual example of the value of radio in an emergency was furnished by the motor ship *Sangvar*, which ran out of oil on her way from the Mediterranean to New York. She was obliged to put into Ponta Delagada where only heavy oil was found to be available. Not knowing how to use this, the captain sent a message by radio to the company's engineers and first aid—in this case, the necessary information—was returned *via* the ether.



Kadel & Herbert

THE FIRST "MINISTER OF RADIO"

When the Canadian Government recently appointed the Hon. Ernest Lapointe its Minister of Radio it established a precedent that may be followed by other countries. There are 150,000 receiving sets in Canada; they are taxed $1 a year each.

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WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

¶ *In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry.*

QUESTION: Would you advise me to build a single-circuit regenerative receiver or a regenerative receiver that makes use of inductive coupling? The reason I ask this is that there are four families in this apartment house who have receiving sets; when they heard that I was going to get a receiver they came down to see me in a body, and asked me *not* to buy or make a single-circuit set as it would interfere with their sets? Is this true? I have heard of so many single-circuit sets getting "distance" that I had almost decided to make a set of this type. After a while, I decided to write to you and ask your advice. They have agreed to let me abide by your decision.

BRUCE MCKARG

ANSWER: It would be better for you to make either a three-circuit regenerative set that employs loose coupling or if you must have a single-circuit set one that has one stage of radio frequency amplification hooked in before your detector tube. This would prevent re-radiation and would keep you from interfering with the reception of your neighbors.

* * *

QUESTION: What is a good loudspeaker to use? I want one which will give little distortion and yet provide good volume in an apartment house.

V. C. SCOTT

ANSWER: Obviously we cannot tell you to buy any specific manufacturer's wares. To help you, however, we advise you to go to some responsible dealer and ask for a demonstration, and pick out an instrument which suits both your pocketbook and your sense of hearing. Most of the loudspeakers on the market are good in their respective fields, some cost but little and some seem to be high priced. Our advice, then, is for you to decide how much you will spend and then for you to obtain a demonstration of the various instruments which sell at that price. You can pick out the one you like best if you give it a comparative test with the others.

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QUESTION: What is the function of the light in the bulb in my radio set? I have noticed that the brighter I turn up the light in it, the louder the music comes in. This is true of "my set" only, however, for my neighbor has a larger set and I can hardly see the light burning in it at all, and yet the music comes in much louder than in my own set, which has to be well lit up to work at all. This is a puzzling thing to me. But I know nothing of radio except to turn the dials until I hear something.

N. C. WHITE

ANSWER: The "light" in a vacuum tube, is actually only a "by-product." The real thing that makes the tube function is the stream of negative electrons which is given off by the filament when it is heated. In most tubes the filament is made of tungsten which has to be heated to almost a white heat before the electron stream given off from it is sufficiently strong for the tube to operate efficiently. This is evidently the type of tube you are using.

Your friend is probably using a tube which makes use of an oxide-coated filament which gives off the proper electron emission at a lower temperature. This is the reason that your friend's tube does not "light up" as much as yours and yet it works as well as yours. It is not the light in the tube that produces the results—it is the stream of electrons which flow from the filament to the plate which produces the sounds you hear in the telephones.

QUESTION: I am using a triple-coil set for listening to the broadcasting; since the wavelengths have been extended I have had trouble in getting the stations on the higher wavelengths. I am using an L-25 for the primary, an L-35 for the secondary, and an L-75 for the tickler. Will you kindly tell me what to do to increase my wavelength?

LESTER B. HILL

ANSWER: We suggest that you use an L-35, an L-50 and an L-75 coil in the respective circuits mentioned in your request. The antenna tuning condenser should be of .001 mfd. capacity (43 plates) and the secondary tuning condenser of .0005 mfd. capacity (23 plates). This will extend your range so that you will have no difficulty in getting the stations with the highest wavelengths. Be sure that you have a change-over switch for changing the antenna tuning condenser to multiple when tuning in these stations with the higher wavelength.

* * *

QUESTION: Please print a hook-up for a tapped coil, a variable condenser and a variometer, for use with a vacuum tube detector. I want to use a potentiometer control for the "B" battery.

J. KREUTZ

ANSWER: A circuit that may be used with your apparatus is given in Figure 1. The coil L, should be tapped at the 15th, 30th, 45th, 60th, 75th and 90th turns. A grid condenser GC, of .00025 mfd. capacity should be used and a grid leak GL, of 2 megohms. The condenser C, is a bypass condenser of about .001 mfd. The variable condenser VC, of .0005 mfd.

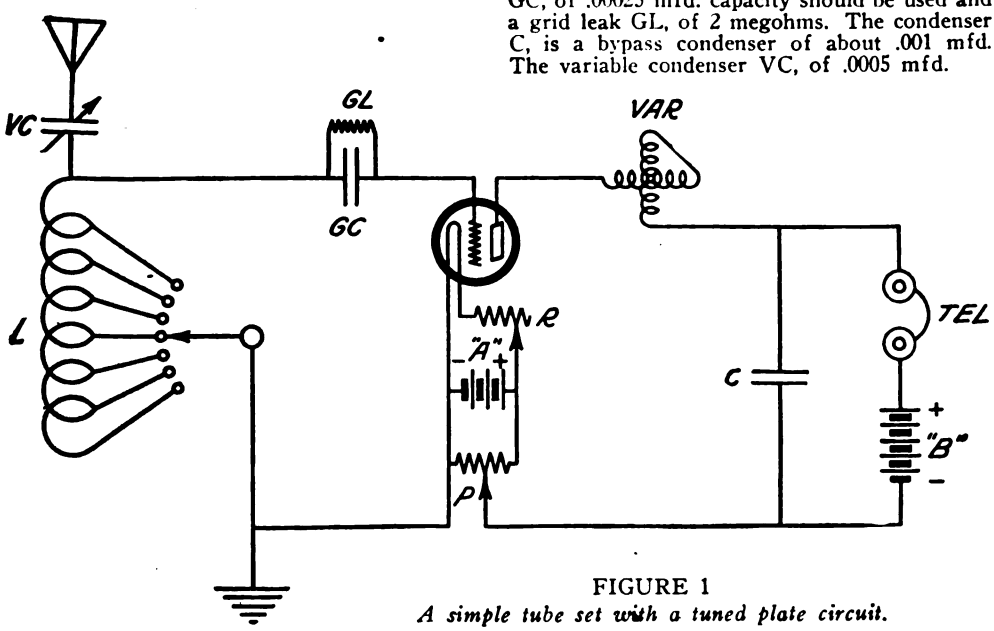

FIGURE 1

A simple tube set with a tuned plate circuit.

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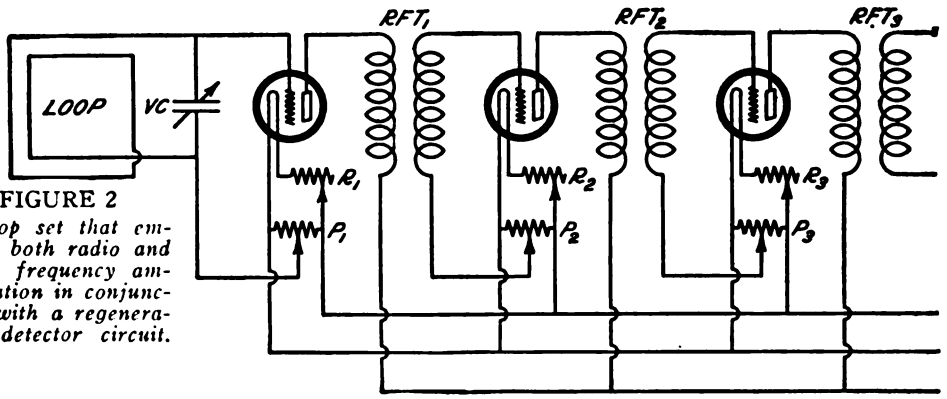

FIGURE 2

A loop set that employs both radio and audio frequency amplification in conjunction with a regenerative detector circuit.

QUESTION: I want to get a circuit that employs three stages of untuned radio frequency amplification with a regenerative detector circuit and two stages of audio frequency amplification. I want to use my set on a loop. Do I need to use potentiometers? If so please show how to connect them.

GEO. H. STONE

ANSWER: We have drawn out a circuit for you in the diagram in Figure 2. If reliable materials are used and the set is put together with care and wired correctly, you should have exceptionally good reception.

The parts to be used are the following:

VC—vernier variable condenser, .0005 mfd.;
GC—mica fixed condenser, .00025 mfd.;
GL—tubular grid leak, 2 megohms;
C—mica fixed condenser, .0005 mfd.;
VAR—variometer;
R1, R2, R3, R4, R5, and R6, filament rheostats;
P1, P2, and P3, potentiometers, 300 ohms;
RFT1, RFT2, and RFT3—radio frequency amplifying transformers;
AFT1 and AFT2—audio frequency amplifying transformers.

If ordinary tubes are used, the filament rheostats should be of 5 or 6 ohms resistance, but if the new thoriated filament tubes or dry-cell tubes are used, the filament rheostats should have a resistance of at least 30 ohms.

* * *

QUESTION: Is No. 30 enameled wire too small for winding a coupler?

H. S. NOBLE

ANSWER: Yes. You should use a larger size. Somewhere between No. 18 and No. 22 would be nearer right. The No. 30 wire would have too high a resistance and it would materially reduce the strength of the received signals.

This is particularly true for use on the coils of a coupler used in a non-regenerative receiver.

QUESTION: Is it all right to make the sub-panel in back of the main panel of the set for mounting the instruments on out of wood?

Jos. M. THIBEAU

ANSWER: Well dried wood which has been treated in paraffin can be used. Ordinary untreated wood, however, should not be used as it contains a large percentage of moisture; this would be liable to cause serious leakage.

* * *

QUESTION: I accidentally pushed my head telephones out of the window and they fell to the sidewalk. Although they did not appear to be damaged outside of a small dent in one side of the shell, they do not work as well as formerly. There are no parts bent or out of place. Will you kindly tell me what is the matter with them?

A. D. REYNOLDS

ANSWER: When a permanent magnet is hit a heavy blow, as with a hammer, a considerable part of its magnetism is lost. This is probably what happened to your telephones. In the fall to the sidewalk the magnets in the telephones were jarred and the permanent magnetism therefore was lost. Send the telephones back to the manufacturer and have them re-magnetized.

* * *

QUESTION: Will you please let me have a diagram of the two-tube Armstrong super-regenerative circuit for use with a loop antenna?

F. S. MASON

ANSWER: This circuit is given in Figure 1 on page 207 of the November, 1922, issue of POPULAR RADIO. A description of this type of receiver was also given in the September, 1922, issue. The new thoriated filament tubes work well with this hook-up.

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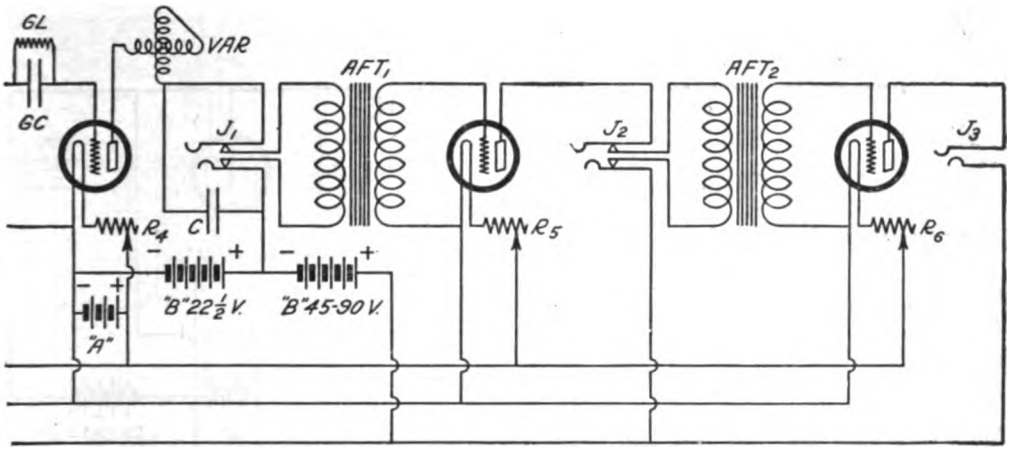

QUESTION: Is it possible to get a two-tube inverse reflex circuit that uses a crystal detector, which will have two stages of radio frequency amplification and two stages of audio frequency amplification and which will operate a loudspeaker when worked on a loop antenna? If so, will you please give me one? Please attach also a list of parts necessary so that I will know what to buy when I make the set. And please let me know the proper constants of the various instruments.

OLIVER WILLIS

ANSWER: The circuit for the two-tube, crystal detector, reflex receiver is shown in Figure 3. You will need the following parts:

VC—vernier variable condenser, .0005 mfd.;
C1—mica fixed condenser, .0025 mfd.;
C2—mica fixed condenser, .0015 mfd.;
C3—mica fixed condenser, .0015 mfd.;
C4—mica fixed condenser, .0015 mfd.;
C5—mica fixed condenser, .002 mfd.;
P1—potentiometer, 300 ohms;
P2—same as P1;
R1—filament rheostat, 30 ohms;
R2—filament rheostat, 30 ohms;
RFT1—radio frequency transformer;
RFT2—radio frequency transformer;
AFT1—audio frequency transformer;
AFT2—audio frequency transformer.

You may use either UV-201-A or C-301-A tubes or any of the dry-cell variety tubes.

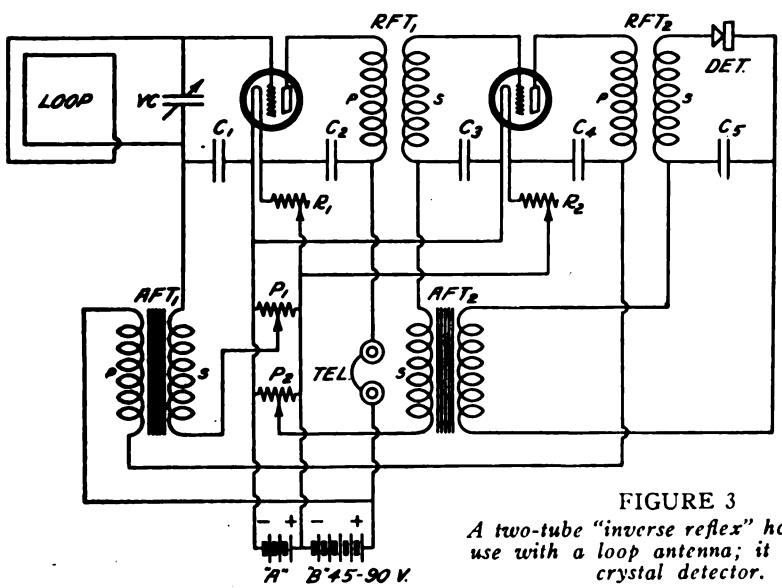

FIGURE 3

A two-tube "inverse reflex" hook-up for use with a loop antenna; it employs a crystal detector.

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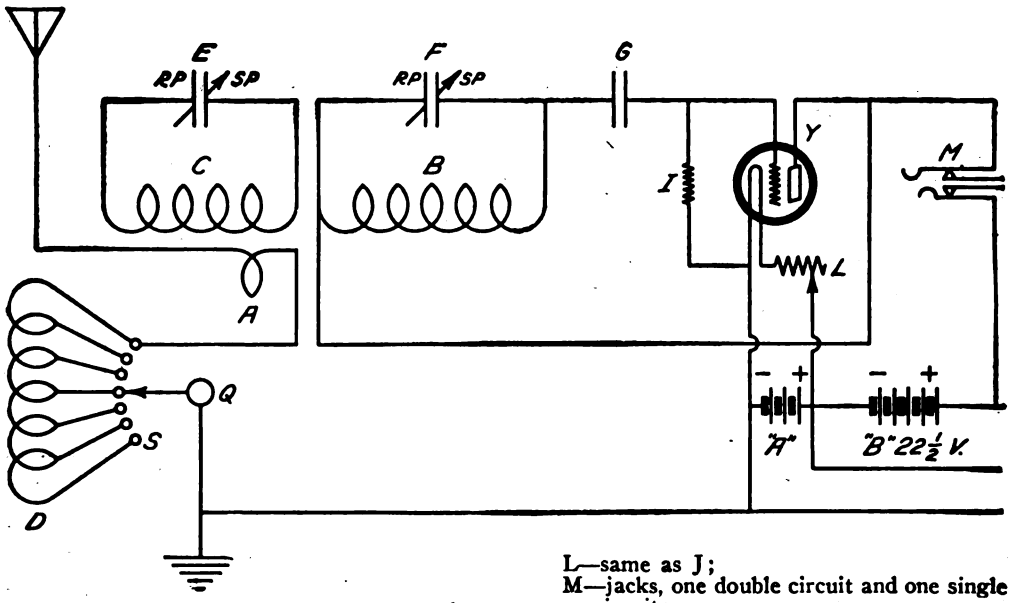

QUESTION: Please tell me what changes will be necessary to adapt the Four-Circuit Tuner for use with dry-cell tubes. I have tried out the circuit with the standard six-volt tubes and find that I can get practically any "DX" station with it even while the local stations are "on the air." Now I want to try the smaller tubes so that I can convert it into a portable set to carry on my car this summer and use with a portable antenna as suggested in the June issue of POPULAR RADIO.

R. LOWRY

ANSWER: In Figure 4 you will find a diagram of the Four-Circuit Tuner adapted for use with dry-cell tubes. The designating letters are the same as those used in the construction article in the May issue, but for the sake of clarity we give the following list of parts:

A—single turn of wire;
B—65 turns of No. 18 SCC wire;
C—34 turns of wire wound close to B on the same tube. (A and B coils are both wound on a tube 3¼ inches in diameter);
D—43 turns of same sized wire, double bank wound on same sized tube, and tapped at the 3rd, 7th, 13th, 21st, 31st turns;
E—vernier variable condenser, .00035 mfd. (.0005 will be suitable for wavelengths up to 600 meters);
F—same as E;
G—mica grid condenser, .00025 mfd.;
H—mica condenser, .001 mfd.;
I—grid leak, 1 megohm;
J—filament rheostats, 30 ohms;
L—same as J;
M—jacks, one double circuit and one single circuit;
N—audio frequency amplifying transformers, high ratio in the first stage and lower ratio in the second stage;
O—switch lever;
R—same as Q;
S—taps (switch points).

The variable condensers should be arranged as shown in the diagram with the rotary plates and stationary plates connected as indicated.

A "C" battery in the grid circuit of the two amplifier tubes is necessary with this type of tube when any considerable amount of "B" battery voltage is used on the amplifier plates. The "C" battery should be an ordinary 3-volt flashlight battery connected with the negative side toward the grid.

* * *

QUESTION: What would be a safe plate potential for a radiotron UV-202 5-watt transmitting tube to be used with the Colpitts circuit? I am going to transmit with D.C. CW., and want to know what voltage my generator should give. I am going to use a 20-watt set with Heising modulation as described in Prof. Morecroft's article in the July issue of POPULAR RADIO.

LAWRENCE STUART

ANSWER: You may use a 150-watt, 500 volt D.C. generator on the four tubes in your new set. It would be good to have a field rheostat in the shunt field of the generator so that you can control the voltage of the output of the generator from 500 volts down to 150 volts. This would enable you to decrease power when working local stations so that you would give as little interference to your neighbors as possible.

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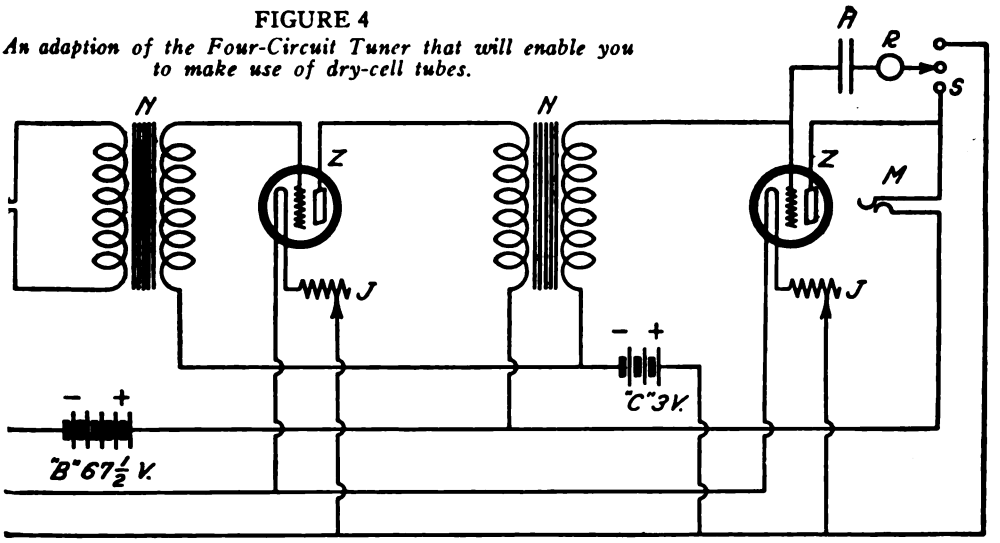
FIGURE 4

An adaption of the Four-Circuit Tuner that will enable you to make use of dry-cell tubes.



QUESTION: Is it possible to use all kinds of tubes on the Four Circuit Tuner, or are only the six-volt tubes suitable? I would like to use the new 1½-volt tubes.

LEONARD CROUSE

ANSWER: The 1½-volt tubes will work nicely in this circuit but the volume will not be quite as great as with tubes employing a greater filament energy.

* * *

QUESTION: What rheostat should be used with a UV-201-A or C-301-A tube when it is used as a detector? I am using a 6-ohm rheostat now and I cannot keep my tubes from oscillating.

VICTOR DENNIS

ANSWER: It would be better to use a 30-ohm rheostat for the detector tube when this type of tube is used. You could then turn down the filament so that the tube would not oscillate.

* * *

QUESTION: Will you send me a hook-up showing how to add one stage of audio frequency amplification to the standard regenerative circuit shown in Figure 2 on page 60 of the May, 1922, issue of POPULAR RADIO?

A. C. HUBLEY

ANSWER: The circuit is shown in Figure 5. We have added a variable condenser in the ground lead. This will improve your tuning.

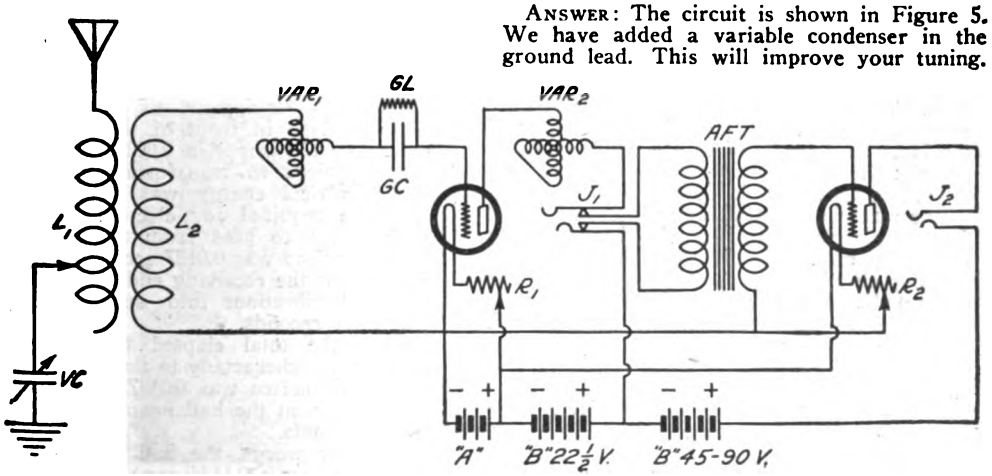


FIGURE 5

A hook-up that employs one stage of audio frequency amplification with the standard regenerative circuit.

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

A New Method of Eliminating Interference

THE progress that is being made toward the elimination of interference by means of short-wave transmission along a radio "beam" is indicated in the following report of experiments that are being conducted by Uncle Sam's scientists in Washington:

A possible solution of the problem of radio interference on point-to-point communication has been put forward by the Bureau of Standards as the result of recent experiments. It involves directional transmission on extremely short wavelengths.

In these tests a parabolic reflector of cylindrical type designed for a 10-meter wavelength was used. It was made by constructing a parabolic wooden frame with a 10-meter aperture. The frame was suspended in the air and 40 wires spaced one foot apart were suspended from it. The power source (located at the focus) consisted of a 50-watt electron tube. The output from the tube was coupled to an antenna, which was a linear oscillator of the Hertzian type tuned to a wavelength of 10 meters; the complete reflector system was arranged so that it could be rotated.

The receiving apparatus was located 170 feet from the reflector and consisted of a single turn loop antenna with a thermo-element in the loop circuit. A portable galvanometer was connected to the thermo-element.

Good directional transmission was obtained. With the reflector turned 20 degrees from the direct line to the receiver the received current dropped to one-half of what it had been with the reflector directed to the receiver. The larger part of the radiated power was confined to an angle of 20 degrees; at an angle of 270 degrees in a general direction away from the direction of the way the reflector was pointing there was practically no radiation.

Furthermore, good radiophone transmission was obtained by this system over a distance of as much as three miles.

* * *

Across the Continent in 0.0187 Seconds

WORDS spoken in a public hall in Schenectady, New York, reached a radio listener in San Francisco, California, 2,550 miles away, before they were heard by a listener only 150 feet from the speaker!

That statement looks a bit fantastic but it is mathematically true. The apparent absurdity becomes reasonable when it is realized that the speed of sound is only 1,126 feet a second at a temperature of 68 degrees Fahrenheit, while the speed of electrical vibrations or radio waves is 186,000 miles a second.

The listener in the back of the hall in Schenectady, 150 feet from the speaker, heard the words in 0.1332 seconds.

A microphone connected to the radio transmitting equipment of station WGY was two feet in front of the speaker and picked up the words in 0.002 seconds. The time required to transform sound waves into electrical energy was 0.002 seconds; the time required for electrical vibrations (or waves) to pass from Schenectady to San Francisco was 0.0137 seconds; the time required at the receiving end to convert the electrical vibrations into sound vibrations was 0.001 seconds.

Thus the total elapsed time from the speaker in Schenectady to the radio listener in San Francisco was 0.0187 seconds, while the listener in the hall heard the words in 0.1332 seconds.

In other words, the San Francisco man heard the words 0.1145 seconds sooner than the man in Schenectady.

C. H. HUNTLEY

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Why We Cannot Hear Amateur Signals from Abroad

ONE sometimes wonders why so many American amateur signals are heard abroad while so few amateur signals from across the Atlantic have yet been picked up in this country. The reasons are told here:

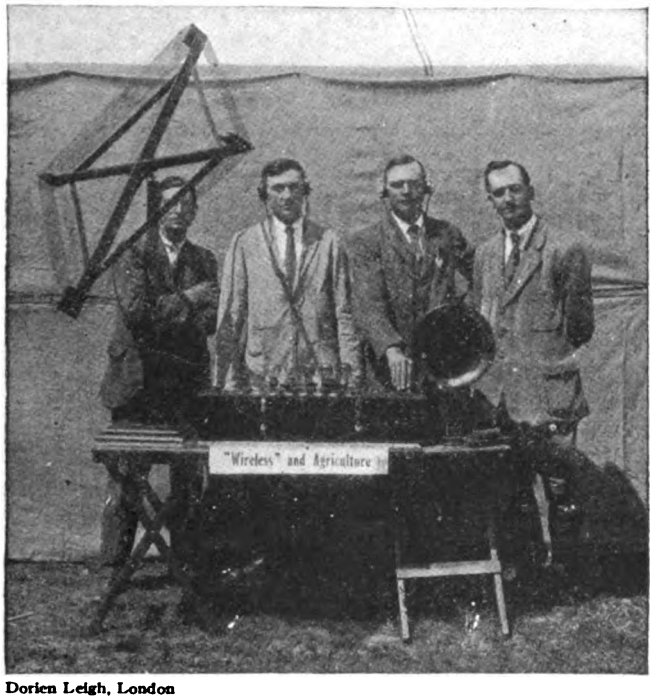
Our English cousins have greatly profited by their government's limitations of amateur transmitting sets; indeed, they have been restricted to ridiculously small amounts of power for transmitting. But this very restriction has proved to be a blessing, for it has turned the efforts of the British amateurs to the improvement of their receiving sets. An amateur in England thinks nothing of using three, four, or even five or six stages of radio frequency amplification in his set, and he has mastered these complicated circuits in such a manner that they are everyday practice in that country.

Here in America, on the other hand, the amateur has gone in for transmitting rather than for receiving. While it is true that he has done some extraordinary work in the development of the vacuum tube transmitter, at the same time he sticks to the one-tube regenerative circuit, with a couple of stages of audio frequency amplification added to it. As a general thing he steers clear of anything that looks like radio frequency amplification.

The American transmitter and the British receiver seem to make a rather good combination, in view of the fact that over a hundred American amateurs reached out across the Atlantic last winter and were heard in England by the British amateurs.

It is possible that if the amateurs of each country study the other's transmission and reception methods we might be able to get transmission from England to America, thus enabling us to talk both ways instead of only one way. That should be the next development in amateur radio.

FREDERICK SIEMENS



Dorien Leigh, London

BRINGING IN THE CROPS BY RADIO

The restrictions imposed by the British government upon the use of transmitters has turned the attention of the amateur in England to the receiving end of radio, which he has developed to a high grade of efficiency. With the five-tube radio frequency set shown above that employs a loop antenna (a typical British outfit) market reports from London can be brought in on a loudspeaker at the farm itself, thus enabling the farmer to take advantage of the most favorable prices. In England as in America this has already become one of the most important services that are performed by radio.

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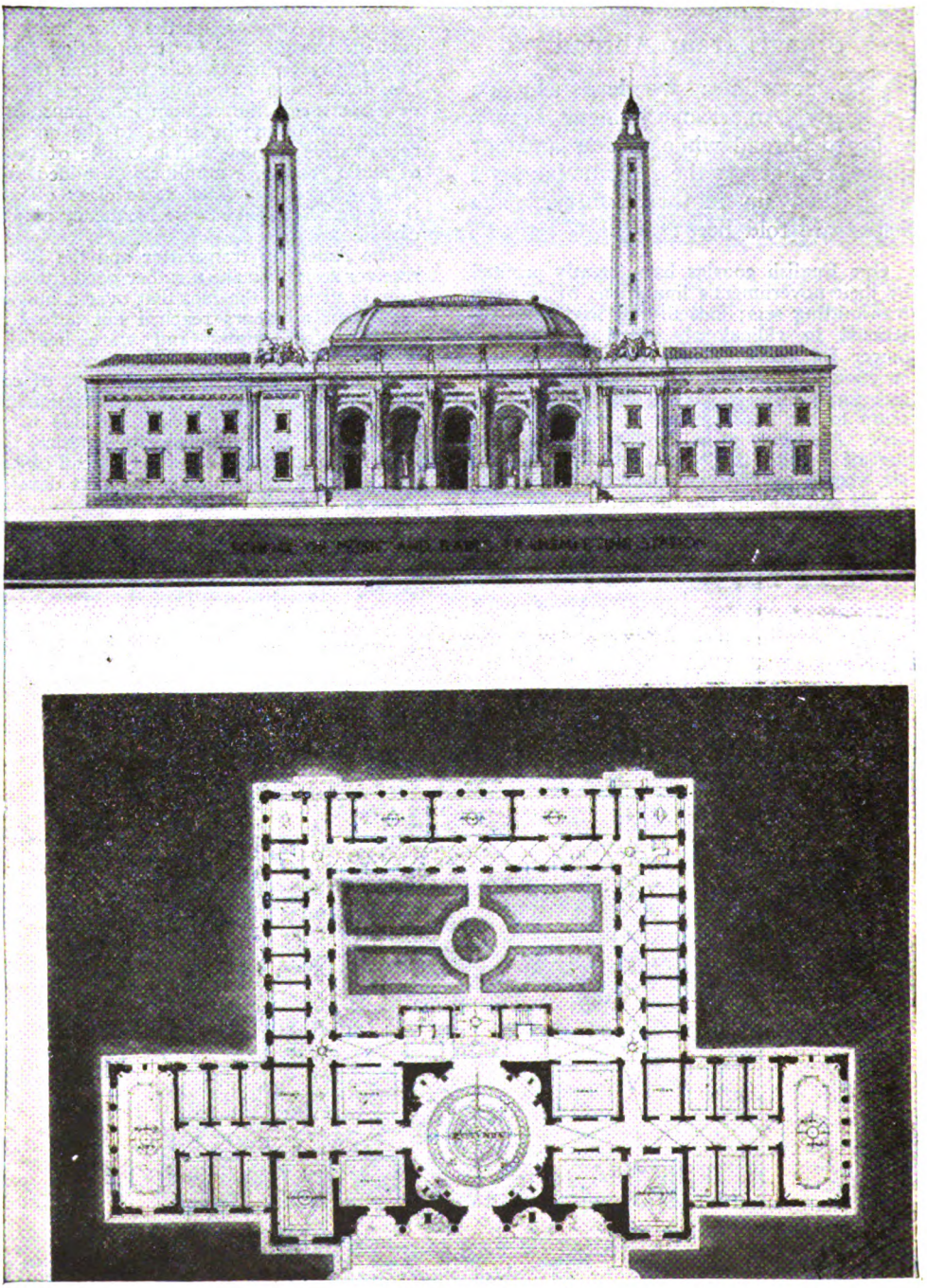

WILL THE BROADCASTING STATION OF THE FUTURE LOOK LIKE THIS?

Here is the idea of a young architectural student, Harold H. Owen, of the kind of building that might be erected by a city of a million inhabitants which wanted a new home for its school of music, with full radio equipment. This design won ***First Mention Placed.***

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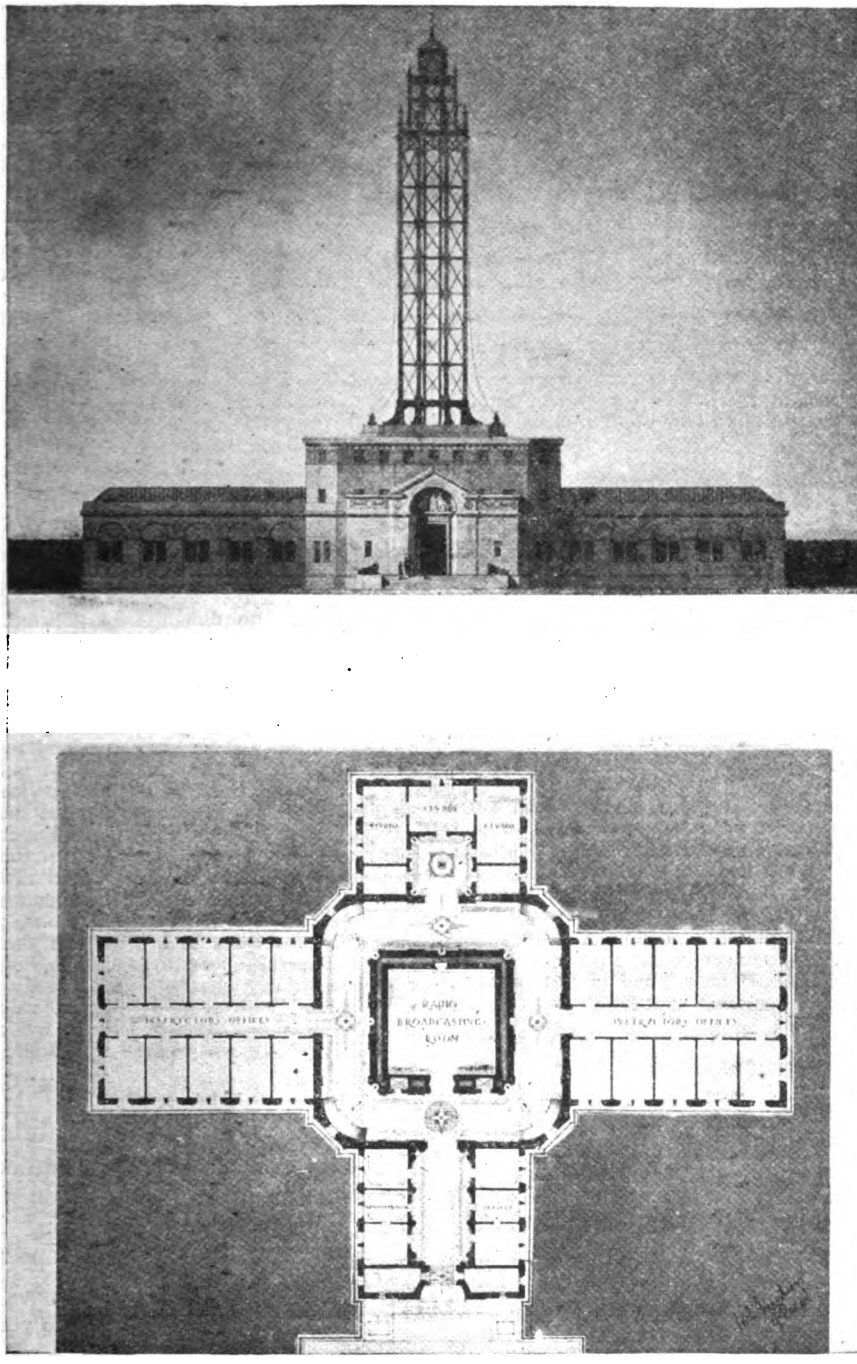

WILL THE CONCERT HALL OF TO-MORROW BE IN EFFECT A BROADCASTING ROOM?

Such is the idea of directing heads of the School of Architecture at Columbia University in New York, whose recent "problem," devised for their students, brought forth some interesting ideas. The above design by José Fernandez received First Mention.

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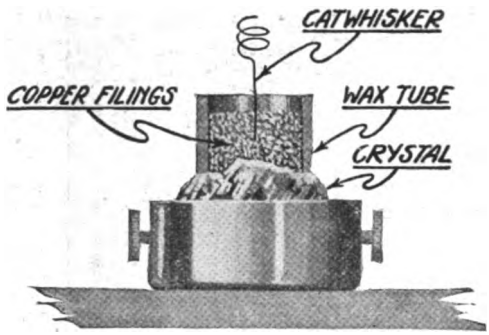

HOW THE ADJUSTMENT WORKS

By means of closely packed filings contact is made with the whole surface of the crystal, thus assuring a circuit through some sensitive spot.

How to Make a Permanent Adjustment for Your Crystal Detector

A RADIO fan in Pittsburgh, Pa., was bothered by the continued adjustments he had to make on the detector of his crystal set. The device he here describes overcame the difficulty for once and for all:

Roll out a flat piece of wax and form into a cylinder of a size to fit your crystal. Slightly heat one end and while soft fasten to the top of the crystal, as shown in the illustration. Then fill with copper filings and insert the catwhisker into the filing. The many small pieces of copper will make innumerable contacts with the crystal and there is sure to be a good circuit through one of the sensitive spots.

HARRY WERLING

* * *

Weather Reports by Radio from the Seven Seas

ACCURACY in weather forecasting can be attained only by complete and more or less simultaneous reports from all parts of the world. Radio has already established its value to weather forecasters by enabling stations located in heretofore inaccessible parts to send in reports; its next service in this line—according to this announcement that comes to us from Washington, D. C.—will be to extend the territory covered by the Weather Bureau so as to include even the high seas:

The extension of the daily weather forecasts to cover the entire North Atlantic ocean is characterized as an imminent development of meteorology by Major E. H. Bowie, chief forecaster of the U. S. Weather Bureau, who has recently returned to Washington after a round trip to France on the French merchant training steamship *Jacques Cartier*.

The trip lasted about six weeks and every day of it the forecaster was able to make a morning and night weather map which showed conditions over the whole North Atlantic, the whole of Western Europe and the whole United States and Canada. Reports were received by radio from vessels at sea, from the Navy station at Arlington, and from the French station at the Eiffel Tower.

Forecasts for the ocean between the tropics and the latitude of Iceland were made and broadcast every day from the *Jacques Cartier* at noon, Greenwich Time. The reports from vessels were relayed to Europe and to America where they were of great value to forecasters there by informing them of storms which were on their way across the ocean.

There was no difficulty in getting vessels to furnish the necessary data. They were all anxious to co-operate. This was true even of the big liners which hold their courses irrespective of the weather.

It is entirely practicable, Major Bowie says, to put out daily forecasts at sea and to broadcast them by radio for hundreds of miles.

Furthermore, the cost of this service would be inconsiderable if the principal maritime nations co-operated. Experienced meteorologists and forecasters could be distributed on vessels so that one or two would always be at sea; they would receive the reports from other vessels and from land stations, prepare the daily forecasts and broadcast them, and relay the vessel reports to land. The weather of the ocean can be charted just as easily as that on the land with results of great value both afloat and ashore. It is a field of work which up to now has been greatly neglected.

WATSON DAVIS

* * *

A Practical Indoor Antenna

IF you cannot put up an outdoor antenna, here is a suggestion for an indoor antenna that will bring in the signals and will not spoil the appearance of your room:

My landlord will not allow me to put up an outdoor antenna but I get very good results by running a wire in back of the picture molding down one side of the entry hall of my apartment and back on the other side to my apparatus. Only one end is connected, the other end being left free. I am using a single-tube set and I get all the local stations.

WILLIAM CASTRO

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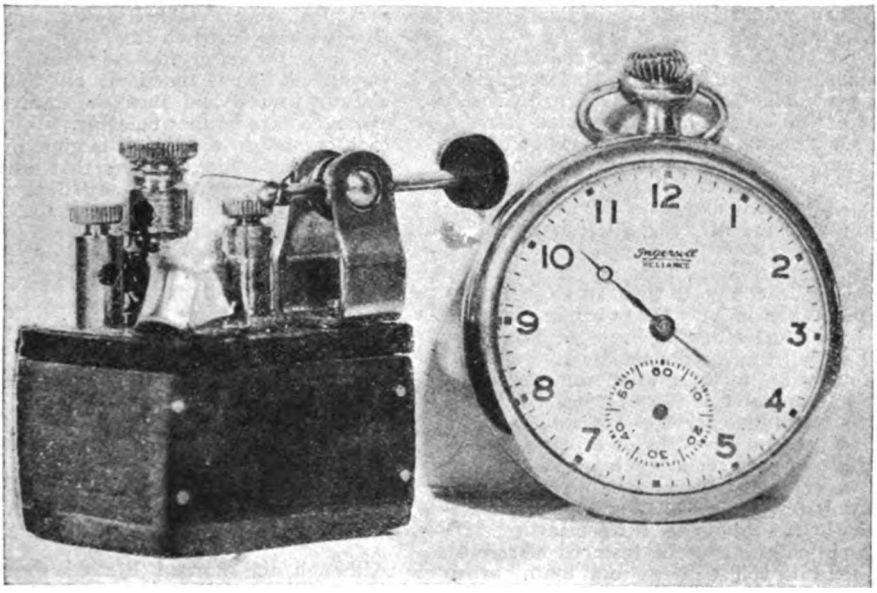

A COMPLETE RECEIVING SET THAT COSTS 35 CENTS

And that is made from materials which can be obtained at a five-and-ten-cent store. The coil (which is packed in the small box) is made of twelve feet of wire.

A Radio Set the Size of a Watch

IF an epidemic of incendiarism should break out in Boston, the local broadcasting stations would lose that part of their audiences that includes the fire department; indeed, the life of a fireman is peculiarly suitable to the development of a radio fan. One fireman, James J. Harrington, has recently built a miniature receiver that is literally "the size of a watch." How he did it is described below:

The set developed by Harrington is remarkable for its small size, low cost, and the loud clear reception which it gives. The material of which the set is made costs only 35 cents—exclusive of the headphones.

The wonderful results obtained with this set, which is small enough to fit in a vest pocket, are due to the manner in which the coil is wound.

Twelve feet of No. 26 wire is wound on a piece of cigar box ⅜ inch by ⅛ inch in size. There is about ⅛-inch space between each parallel wire and each layer is wound back over the preceding layer. The coil is contained in a box made of cigar box wood which is 1½ inches long, 1¼ inches wide, and ⅞-inch deep.

On top of this box is mounted the crystal holder which may be bought for ten cents. This holder is made of fiber; the price includes a catwhisker and two binding posts. A third double binding post is placed between the single posts. This costs ten cents extra. A crystal may be bought for ten cents and the wiring and leads cost about five cents.

The coil is connected between the bottom of the crystal receptacle and the ground binding post. The top is then glued or screwed to the box. When this has been done the set is ready to use. A pair of headphones are obtained. The antenna and ground connections are made. All that remains is to adjust the catwhisker to the most sensitive spot of the crystal.

HARRY BELKNAP

* * *

How to Keep Your Crystal Detector Free of Dust and Grease

HERE are some practical hints for radio fans who use a crystal detector; they come from a New Jersey fan who is a veteran crystal user:

The greatest enemy to the sensitivity of a crystal detector is dust. The next greatest enemy is grease—especially grease from the hands of the operator. Grease and dust collect on the surface of the crystal and form a thin film which seriously affects the detector.

Trouble due to dust can be taken care of easily by enclosing the sensitive crystal in a glass case. This is generally done by the manufacturers of high-grade detectors, but

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the cheaper detectors do not ordinarily have this feature.

In the old days when the crystal was used by almost every amateur, the enclosed detector was not known. It was up to the user, therefore, to protect his own crystal. He did it in this way: he went to the cellar or the attic and obtained a glass jar of some sort. This he took to the "wireless room" and inverted it slowly and carefully over the sensitively adjusted detector where it served as a dust cap.

This may still be done by the amateur whose set is equipped with an exposed detector. When he gets the cover in place, he will have a detector that keeps sensitive and stays in adjustment almost indefinitely.

Trouble due to the grease from the hands may be eliminated if the operator is careful not to touch the crystal. He should use a pair of surgeon's forceps or a pair of pliers for removing or replacing his crystals.

If a crystal detector has been covered with dust or grease and thus rendered insensitive, it need not be thrown away. Its original qualities may be restored merely by brushing it well with an old tooth brush that has been soaked in alcohol. Then allow the crystal to dry in some place that is free from dust.

Crystals for a detector should never be bought one small piece at a time; they should be bought by the pound or half-pound. In the long run it is cheaper to buy them this way. There are more sensitive pieces in a half-pound than in four or five "selected" boxes.

A quantity of crystal should be obtained and be broken up into pieces that will fit into the detector cup. These pieces should be placed on a piece of tin-foil which is connected to one side of the detector. The other side of the detector should be connected to a flexible wire which has a stiff piece of bare wire soldered to it.

The sensitive crystals are found in this way: a station is tuned in on the crystal already in use and then the catwhisker is removed from the detector. After that each crystal on the tinfoil is gone over with the stiff bare wire. Pieces that do not test well are broken up and tested again. This operation is continued until all the sensitive pieces have been found.

LEROY WESTERN

* * *

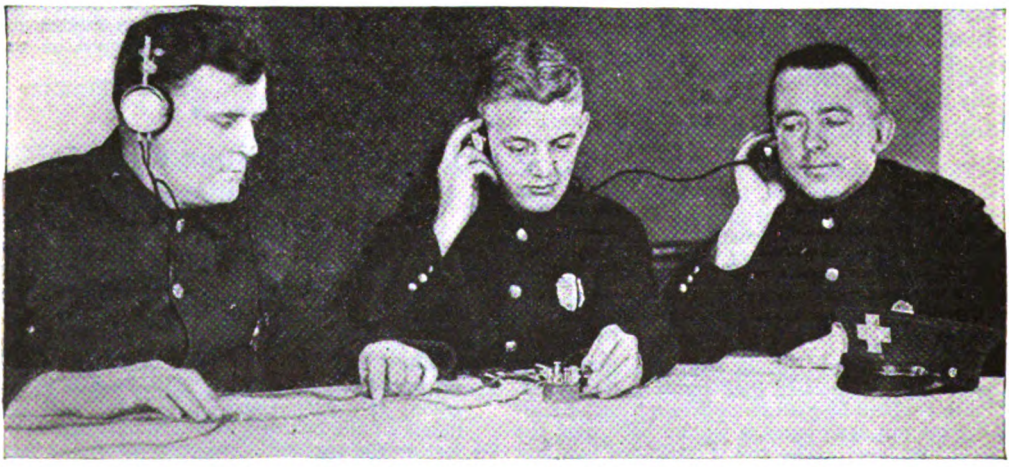
How to Protect Your Tube Filament

THE radio fan who has cost himself both trouble and money by accidently burning out the filament of his vacuum tube will appreciate this practical advice as to how to protect it:

Although the normal life of the average radiotron filament is more than 1,000 hours, it will be burned out in an instant if the high voltage leads from the "B" battery are connected across it. The burn-out requires but a fraction of a second; consequently it frequently remains unnoticed until the set is used again. This causes great inconvenience—particularly if a new tube cannot be obtained immediately.

Fortunately, however, it is an easy matter to protect the filament. Merely insert a 25-watt, 110-volt tungsten lamp in the circuit. The resistance of this automatically increases with the current and it becomes an effective ballast lamp that will prevent all injury.

J. L. BERNARD



ENTERTAINMENT FROM A TWO-INCH BOX

Although the set constructed by Harrington is less than two inches long, it brings in radio music from local stations strong enough to furnish entertainment to three firemen at once.

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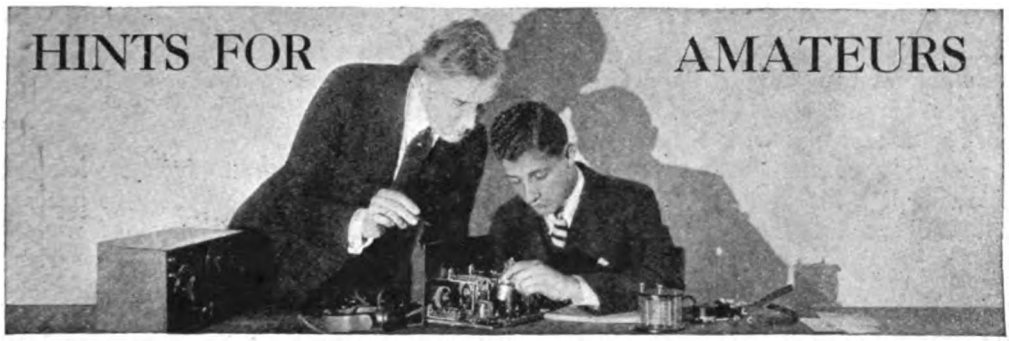

ONE of the most annoying features of radio reception is the trouble due to body capacity. If you have to hold your hand near the dials in order to keep a distant station tuned in, you lose most of the pleasure of receiving. And this trouble is not necessary in any set. It can be eliminated in the following way: Connect the rotary plates of the variable condenser to the ground; if the variable condenser is in the secondary circuit, connect the rotary plates to the filament side of the circuit. If the trouble is experienced with the plate variometer, connect the stator windings to the plate and the rotor windings to the "B" battery.

* * *

A SMALL bit of sealing wax dropped on the edge of the winding of a coil will be sufficient to hold the wires from slipping. *Never use shellac on the windings.*

* * *

SOME beginners have their sets grounded on the water pipes, some on the steam radiator system, some on the fire escapes and some on the gas fixtures. It often improves reception to use all of these together, running a wire which connects them all to the ground terminal of the set.

The gas pipe should *not* be used, however, owing to the danger of fire.

MANY users of radio sets are not getting all they could out of them because they are not using the correct plate voltage on the detector tube. Try tuning in a weak and distant station and then changing the tap on the "B" battery until the best results are obtained.

* * *

START out in radio by making a small crystal set or a simple single-tube receiver. By doing this you will learn what goes into a set and you will understand more clearly what you are doing when you begin to tune in with more complicated instruments.

* * *

WHEN putting up your antenna do not forget to solder every joint; if you neglect to do so the joint will corrode and will offer great resistance to the feeble currents that are trying to flow in the antenna. Do not let your haste get the upper hand and cause you trouble in the end. The correct way to make a joint is shown in the accompanying diagram, Figure 1.

* * *

ERECT your antenna as high as possible and give your radio set a good start.

* * *

A RADIO set is no better than its weakest part.

HOW TO MAKE A JOINT IN YOUR ANTENNA

FIGURE 1: *A poor antenna joint is a sure cause of loss of efficiency. Insure good results by making a neat workmanlike joint.*

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THE radio experimenter who builds the whole or even part of his set should provide himself with a set of tools to work with that will enable him to make a good job of the construction. The following is a list of the tools which he will find are almost indispensable:

1 pair of 6-inch electrician's wire-cutting pliers;
1 pair of 4-inch electrician's wire-cutting pliers;
1 small breast drill capable of holding a ½-inch drill;
1 complete set of small drills up to ¾ inch;
1 brace and bit;
1 set of small files including round and triangular files;
1 countersink drill;
1 6-inch screwdriver with ¼-inch spade;
1 6-inch screwdriver with ⅛-inch spade;
1 8-inch screwdriver with ¼-inch spade;
1 electric soldering iron (½ pound);
1 can of soldering paste;
½ lb. of strip solder;
1 small center-punch;
1 pair of dividers;
1 15-inch brass-edge rule;
1 6-inch square;
2 small steel clamps;
1 small hand grindstone;
1 hacksaw and medium-sized blades.

If he provides himself with these tools he will never have to dig a hole in his panel with a penknife, or whittle away at a piece of tubing with rising temperature and temper.

* * *

To enable your set to receivve longer waves (and this will probably be necessary with the new assignment of wavelengths), insert a loading coil in series with the circuits that you are using or shunt them with a variable condenser.

* * *

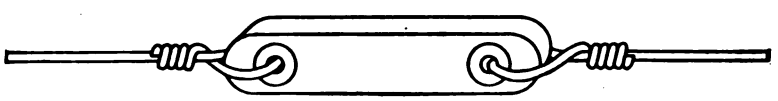
OFTEN the contacts underneath your vacuum tubes become corroded and the circuit is not properly completed. It is a good plan to sandpaper the ends of the contacts occasionally, thus keeping them bright and shiny.

* * *

IF you use the small 1½-volt tubes it is extremely important to mount the sockets on a piece of sponge rubber when more than one stage of amplification is used. If you neglect to do this you will be troubled by microphonic noises when you are tuning.

* * *

IT is always a question with a beginner as to what kind of insulators to use with his receiving antenna. Suitable insulation may be obtained by using the ordinary glazed porcelain cleats shown in Figure 2. These may be purchased at any electrical store. Their cost is slight, but they are just as effective as any of the more expensive kinds. They should not be used for transmitting, however, unless two or three of them are connected in series.



A PRACTICAL INSULATOR THAT COSTS BUT A FEW CENTS

FIGURE 2: *These porcelain cleats may be obtained at any electrical store. If you have a transmitter you should use two or three connected in series.*

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If you are getting good results with your receiving set, tell your fellow-readers of POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

A REMARKABLE RECORD FOR A CRYSTAL SET

A HOME-MADE crystal set which receives from a station 800 miles away is reported by Henry Willier of Washington, D. C. He made the set himself, he states, and is but 12 years old. WWJ of Detroit, Mich., is the record station. Others are WJZ, Newark, N. J.; WEAF, New York City; KDKA, Pittsburgh, Pa.; WHAS, Louisville, Ky.; 8HT, an amateur in Buffalo, N. Y., and WGY, Schenectady, N. Y.

The aerial used is made of one wire 110 feet long and 35 feet high. The instruments are, a variocoupler, a tuning coil, and primary and secondary condensers. The set cost less than $20.

* * *

THREE SPIDER-WEB COILS BRING IN "DX"

A TOTAL of fifty-nine stations brought in by three spider-web coils and one tube is the record of Dewey Lee of Elwood, Ind., and he attributes his success to the use of a variometer in connection with the coils. The variometer is placed between the plate and the antenna and is used as a help to the tickler coil in controlling regeneration.

The most distant stations he receives are KHJ and KFI of Los Angeles, Cal.; CJCG, Winnipeg, Canada; CFCF, Montreal, Canada; PWX, Havana, Cuba, and KQY, Portland, Ore. His coils are made of 35 turns for the primary, 50 for the secondary and 50 for the tickler. Although he has had good results with similar coils of the honeycomb type, he likes the spider-web type better.

* * *

HE PICKS UP HALF THE COUNTRY ON ONE TUBE

EVERY large station in the eastern and middle western states comes in on one tube in the set of Robert E. Steele, of Brodhead, Wis. WBAP at Fort Worth, Tex., 850 miles away, is received regularly and KHJ of Los Angeles, Cal., is frequently picked up.

The set is home-made. It consists of a variocoupler in a regenerative hook-up and a 43-plate condenser in the antenna circuit. The antenna is one wire 150 feet long and about 25 feet high, strung between trees.

* * *

FROM CANADA TO TEXAS ON A CRYSTAL

L. J. HOGG of Norwood, Canada, claims the record of receiving WBAP of Fort Worth, Tex., a distance of 1,225 miles, on his set, consisting of a crystal detector, variocoupler and 43-plate condenser.

"I do not think I get re-radiation from a tube set," he says, "because there is none within a mile of me and I never hear a whistling noise with the music."

He uses one wire 110 feet long and 35 feet high for an antenna, with a lead-in of 40 feet. On any cold night he can pick up WLAG, Minneapolis, Minn.; KSD, St. Louis, Mo.; WCX, Detroit, Mich., besides a number of others.

* * *

A FAN WHO "TUNES HIS EARS"

LEO R. FARBE, of New Orleans, La., hears CFCF, Montreal, Canada, using an aerial, counterpoise, and his radio frequency set of five tubes. His aerial has four strands, two feet apart, is 40 feet high and 100 feet long. The counterpoise has similar dimensions and is stretched eight feet from the ground.

The set tunes sharply and sometimes picks up as many as twenty-six broadcasting stations in an evening, as well as many ships at sea. Farbe says he has learned much about delicate tuning in order to establish his record, but he has also learned almost as much about careful listening and says he could not get along without his "sponge rubber ear caps."

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2,225 MILES ON A SOAP BOX

WITH a few little things in a soap box, E. O. Knoch in Los Angeles, Cal., hears PWX of Havana, Cuba, about 2,225 miles away. He uses only one tube in a single-circuit regenerative hook-up and he hears over thirty distant stations, ten of which are more than 1,000 miles away. His panel and cabinet are made from the wood of an ordinary soap box. He has discarded his ordinary rheostat and his success is due, he thinks, to the carbon-disk rheostat, with which he has replaced it; before he could hear no farther than KFDL, Denver, Colo.

Some of his other records are WFAA, Dallas, Tex.; KFC, Seattle, Wash.; KSD, St. Louis, Mo.; WAAC, New Orleans, La., and WOC, Davenport, Ia.

* * *

A TWELVE YEAR OPERATOR OF A SINGLE-SLIDE "EXPRESS"

"IF anyone can beat this, let him write me," says Geo. L. Merkel of Milwaukee, Wis., throwing down the gauntlet to all comers; he gives point to his challenge by announcing that he hears forty-two stations with a single-slide tuning coil and a crystal, and that he is only twelve years old.

The coil which does this is made of No. 20 enameled wire, wound on a cardboard tube 3½ inches in diameter. He uses a two-wire antenna 45 feet long and 35 feet high.

He hears WSB, Atlanta, Ga.; WEAF, New York City; WHAS, Louisville, Ky.; KDKA, Pittsburgh, Pa.; WHB, Kansas City, Mo.; WGY, Schenectady, N. Y. and WHAZ, Troy, N. Y.

* * *

A SET MADE OF STANDARD PARTS

BY purchasing standard parts and connecting them himself, George C. Morgan of Ozark, Ala., has built a three-tube set with a vario-coupler and two variometers which brings in 95 stations and covers the distance between Los Angeles, Cal., and Medford Hillside, Mass. He is fifteen years old and says he did it all himself. His antenna is a single wire 100 feet long and 40 feet high.

WBAP, Fort Worth, Tex., and WHB, Kansas City, Mo., come in loud enough to be heard out in the street when he uses his loud-speaker. Others he hears are KHJ, Los Angeles, Cal.; WLAG, Minneapolis, Minn.; WBZ, Springfield, Mass.; WMB, Auburn, Me. and PWX, Havana, Cuba.

* * *

AN EXCELLENT RECORD FOR A SMALL SET

HAROLD J. O'CONNOR of New Rochelle, N. Y., receives 21 stations which are over 1,000 miles away, by using three spider-web coils and one stage of audio frequency amplification. He says his set is remarkably easy to tune and that almost all tuning is done with his secondary condenser. He uses a single wire 130 feet long and 25 feet high for an antenna.

KHJ, Los Angeles, Cal., comes in on the detector alone. Others he has heard are KYW, Chicago, Ill.; WKAQ, Porto Rico; WWJ, Detroit, Mich.; WSB, Atlanta, Ga., and WHAS, Louisville, Ky.

* * *

TO MEXICO CITY ON A DRY-CELL TUBE

BROADCASTING from Mexico City in Mexico was picked up by Cecil Sanner in Toledo, O., before he had been listening in a week, according to his letter which states that he uses only one dry-cell tube. He uses a tapped coil placed in inductive relation between his plate and grid variometers. The tuning is accomplished with the three inductances and a 23-plate condenser in the grid circuit.

Other stations he hears are PWX, Havana, Cuba; WMB, Auburn, Me.; WBAP, Fort Worth, Tex.; WGM, Atlanta, Ga.; WGY, Schenectady, N. Y., and WLAG Minneapolis, Minn.

His circuit is given in Figure 1.

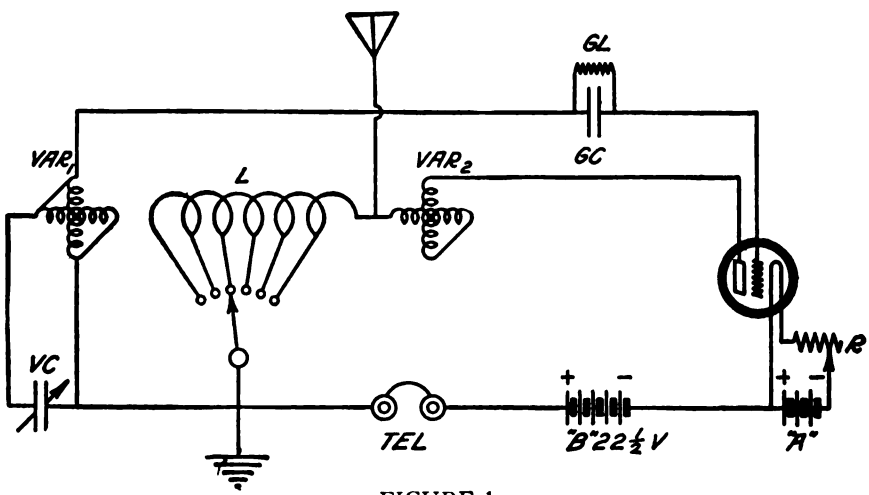

FIGURE 1

A single-tube circuit that employs a tapped coil placed in inductive relation between the plate and grid variometers. The rotor and stator windings of the grid variometer are connected in parallel.

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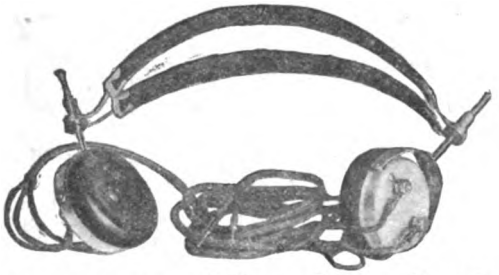

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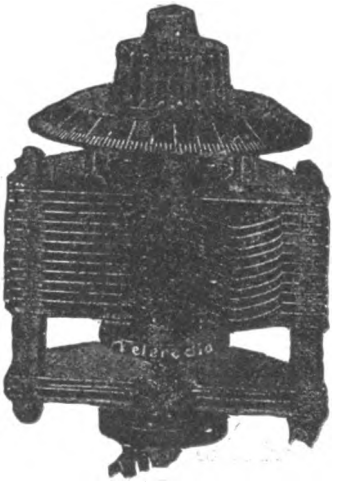

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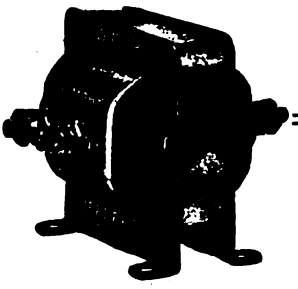

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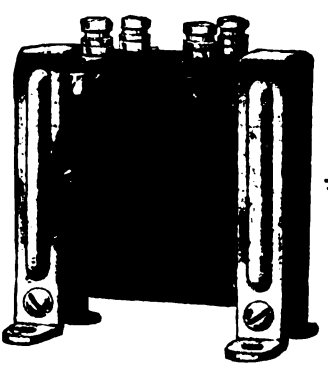
The five Jefferson types meet the demand for an audio-frequency transformer for every requirement. In this assortment you are sure to find the transformer which will make your set super-sensitive, and enable you to tune in distant stations with ease, and freedom from distortion.

Radio Bulletin Sent Free

Jefferson Electric Mfg. Co.
427 S. Green Street Chicago



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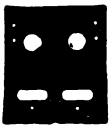
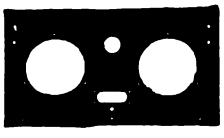
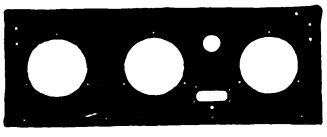
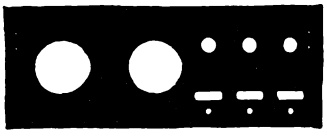
EISEMANN

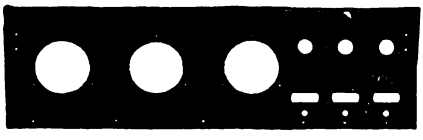
Speaking of Portable Sets—







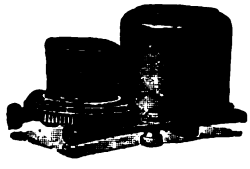


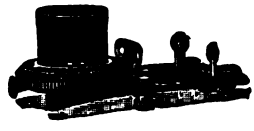


AN ideal vacation set may be built with these units.

No special packing case is required, owing to the absence of protruding knobs and smooth surface of panel.

The concave dials, aside from adding attractiveness to a receiving set, increase its utility.





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William N. Shaw, *President*

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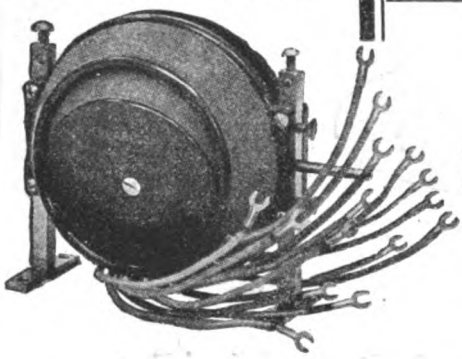
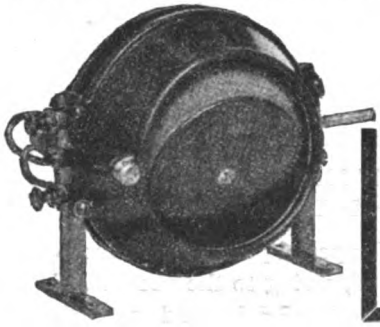


PIGTAIL CONTACT VARIOMETER



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Noise and disturbance are practically eliminated. The SP2 is listened to with genuine delight. It gives a QUALITY performance; the entertainment as afforded by broadcasting stations EVERYWHERE—and **at its** best.

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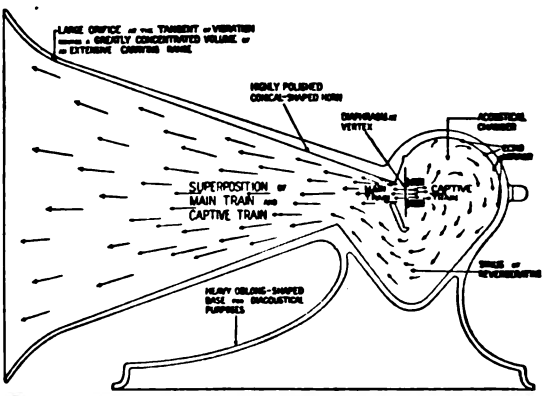
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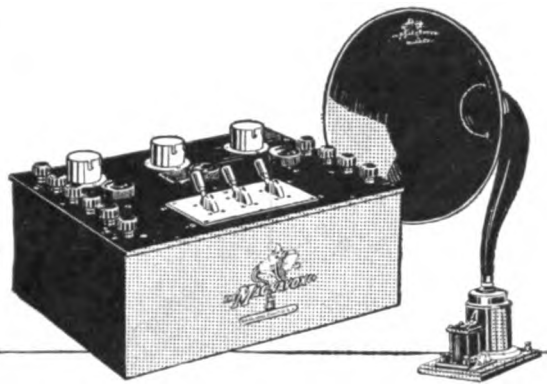

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THE radio engineers of the Magnavox Company have given their approval to Formica in the most sincere and convincing way—by using it exclusively in their apparatus for a long time.

Think over the list of great independent radio manufacturers whose standing and prestige in radio counts for something, and you will find almost every one among the regular users of Formica.

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FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

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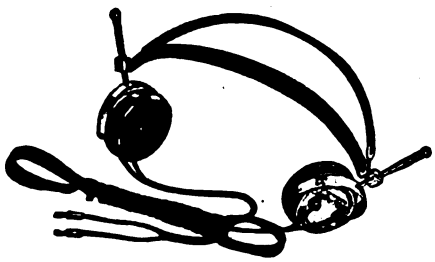
AMPL-TONE PHONES



2200 Ohms—$6.00

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"ALL-AMERICAN"

Amplifying Transformers
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as standard equipment in their sets. This is reason enough why any man building his own set should use "All-American" Transformers. The sales of these manufacturers depend on the efficiency of their apparatus. The Confidence they place in "All-American" Transformers to function properly under all conditions is proof of the quality of these instruments. Buy them—use them—and you, too, will endorse them. Every live radio dealer carries them. To help you get the best results from your radio set we offer FREE a book of twenty-five tested hookups. Send 2c stamp for postage.

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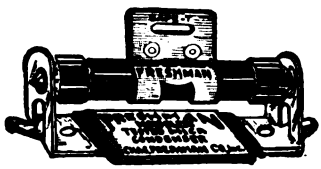
A Fixed Resistance Leak Combination—4 in ONE



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Freshman Fixed Leak
SAFE-T HANDLE

Price Complete

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Furnished in any value of resistance from ½ to 10 Megohms

Separate Condenser and Mountings..40¢
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At your dealers. Otherwise send purchase price and you will be supplied without further charge.

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Radio Condenser Products

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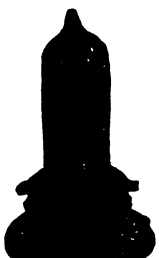

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It's the contact that counts

A careful examination will show that each contact in Na-ald sockets and adapters is of a wiping nature on a broad surface, and of sufficient tension, and so designed that tension is permanent, no matter how often the bulbs may be removed and how much the connecting prongs in the tubes vary.

Also it is little realized that sockets are being sold which, owing to faulty choice or control of material, develop current leakages from plate to grid that rob many otherwise well-made sets of their efficiency. Na-ald sockets in their design avoid all these troubles.

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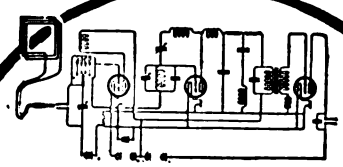

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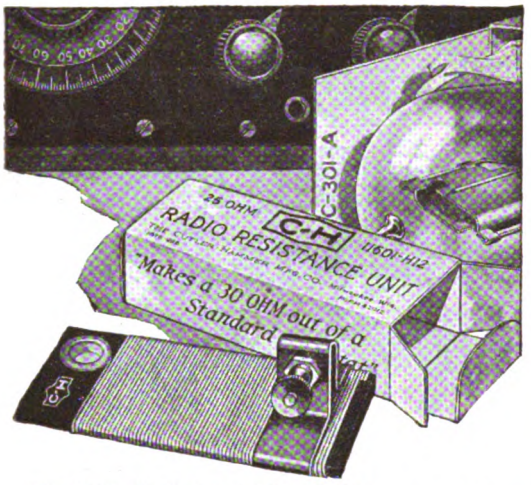

The C-H Radio Resistance Unit attaches instantly to your present rheostats for control of the "A" type tubes. Saves the cost of new rheostats, as well as the trouble of redrilling your panel. Buy one with each new tube and enjoy better reception tonight. Price 25c at dealers everywhere.

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Milwaukee, Wisconsin

C-H

More than one-half million C-H Radio Rheostats now in use.

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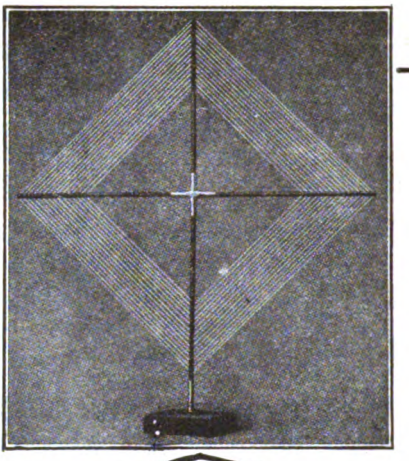

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4 inch molded dial-detachable base.
Hartman loops stay taut and true.
33½ in. wide—36½ in. high—15 turns—4 in. dial.
Write for bulletins on Hartman Radio parts.
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TRADE MARK REG. U. S. PAT. OFF.
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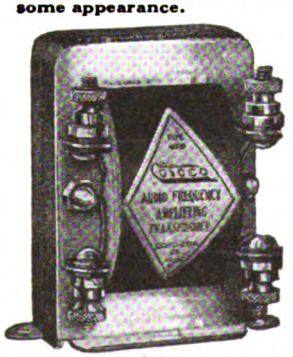
The Audio Frequency Transformer that Combines ALL the Essentials for Complete Satisfaction.

Cotoco Transformers afford all the ideal features listed below and besides are of unusually handsome appearance.



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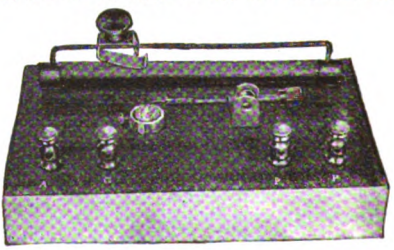
CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



FREE FAMOUS TESCO RADIO Crystal Set (Shown in Cut)

To introduce the wonderful T-B-H radio headset we will give absolutely free of charge, the most efficient crystal receiver on the market.

Send $5.00 for the headset and get this instrument free. Money refunded if not absolutely satisfied.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.

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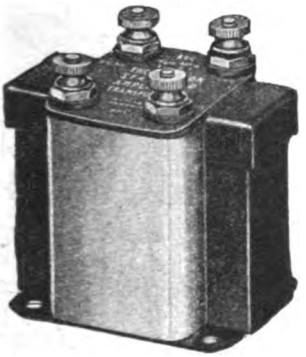


THORDARSON

Volume
Selectivity
Tonal Purity

Amplifying Transformers

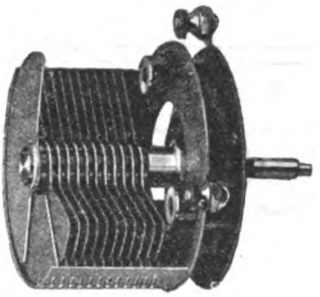
Price, mounted only

6 to 1 ratio transformer (with Red Label)	$4.50
3½ to 1 ratio transformer (with Blue Label)	$4.00

The latest Thordarson developments in audio frequency transformers and variable condensers provide the experimenter and amateur with a positive means to increase the range, selectivity, and volume of broadcast reception. Distortion and internal interference are entirely eliminated through exclusive Thordarson scientific principles, constant supervision and tests at every stage of manufacture and assembly. Local stations and stations broadcasting simultaneously are tuned in or out at will.

Thordarson Built the First
1,000,000 Volt, 25 Cycle Transformer

He has also constructed mammoth transformers for central stations and leading Universities of the United States. No one man is more responsible for the present day efficiency of commercial A. C. transformers than he and that same genius, and 28 years of practical experience has developed audio frequency amplifiers and variable condensers to a degree of efficiency never before attained by any manufacturer. A folder describing their specifications will be sent on request.



Variable Condensers

13 plate .00025 M. F.	$2.00
with vernier, knob and dial	3.50
23 plate .0005 M. F.	2.50
with vernier, knob and dial	4.00
43 plate .001 M. F.	3.00
with vernier, knob and dial	4.50

Sold by all forward-looking radio dealers

THORDARSON
ELECTRIC MFG. CO.

Huron and Kingsbury Streets - Chicago

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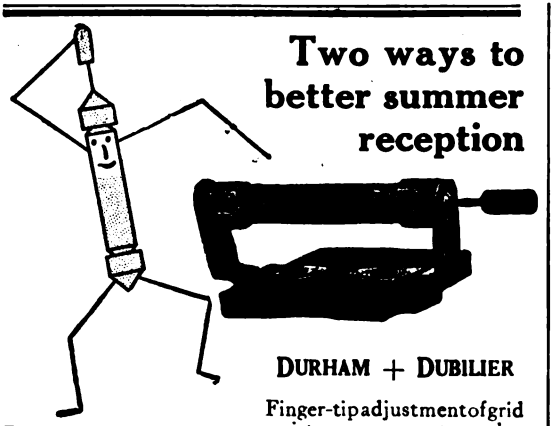

Two ways to better summer reception

DURHAM + DUBILIER

Resistances:
No. 101 —to 5 megs.
No. 201A—to 10 megs.

Condensers:
.00025 mfd.
.00050 mfd.

Finger-tip adjustment of grid resistance, accurate value and sturdy design of condenser—these will hold your tubes to quietest operation thru summer static noises.

Your dealer has them for $1.10

Durham & Co., 1936 Market St., Philadelphia

DURHAM Variables High Resistance

Dealers:—Here's a number that will boost your whole line. For it keeps sets working through the summer months.

50¢

THE PACENT 40

A perfect plug for every radio requirement at a price which enables you to have one on every phone cord. Just one of the many PACENT Radio Essentials affording you more efficiency, convenience and enjoyment from your radio equipment.

Don't Improvise—"PACENTIZE"

Write for Descriptive Bulletins (P-8)

PACENT ELECTRIC CO., INC.
22 Park Place New York, N. Y.

Pacent
RADIO ESSENTIALS

TRADE MARK
Wave Trap
PATENT APPLIED FOR

The Missing Link in RADIO

Stops Interference!

JOHN A. BURRICHTER, 207 E. Ohio Street, Indianapolis, Ind., says:
My set is about ten blocks from one of the local stations and when they started broadcasting, it meant that ended everything for the evening. After your Wave Trap was installed, they were tuned out completely.
Had expected with the approach of warm weather to take down my set until next fall but while other local "Listeners In" are almost entirely cut off by STATIC, I am enjoying the programs just as much as in the cold months.
Have covered distances that heretofore have been impossible and really consider the Wave Trap the greatest invention since radio.
Use the "FERBEND WAVE TRAP" for real results.
THE ORIGINAL WAVE FILTER

8.50 CHARGES PREPAID

Ferbend Electric Co.
21 E. SOUTH WATER ST.
CHICAGO
Circular on request

a Chi-Rad Special!

for W.D.11 tubes~

Standard, threaded rubber, Willard's, specially adapted for use with W. D. 11 tubes. Supply current at 2 volts to one W.D. 11 tube for 210 hours on a single charge. Rechargeable. Brand new, size 4x5½x7 inches—Chi-Rad guaranteed.

2-Volt Willard Charged . . $7.50
2-Volt Willard Dry 6.50

These same Willards can be adapted to deliver 8 volts for pure D. C. for C. W. Transmitters. Better than a generator because no filter is necessary. Much less expensive.

In lots of 40 (320 volts) $160.00

(Better prices on larger quantities.)
Specify dry or charged when ordering.

Chicago Radio Apparatus Co.
415 S. Dearborn St., Chicago, Ill.

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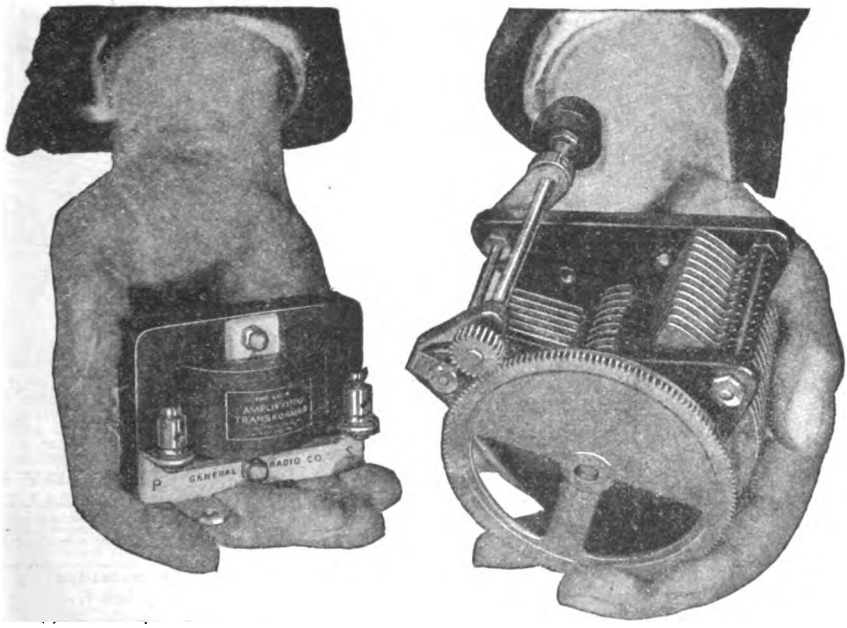
HERE!



Use a Selective Condenser *but* a Non-selective Transformer

Good quality demands equal amplification for all frequencies within the voice range. The 3.7 to 1 ratio of the type 231A amplifying Transformer gives maximum amplification without distortion, in multi-stage as well as in single stage amplifiers.

High ratio amplifying Transformers are selective—and selective transformers have a resonant peak that causes serious distortion. Confine selection to the Condenser.

The General Radio Co.'s type 231A Transformer is suitable for use with UV-201A, 201, 199, WD-11, 12 and tubes of similar plate impedance.

A selective receiver is now a necessity. The new wave length allotments to broadcasting stations have helped to reduce interference, but the large number of broadcasting stations and the fact that the available band of wave lengths is limited, render a selective Condenser a necessity.

For selectivity, sharp tuning and fine adjustment, use a General Radio Co.'s type 247, 500 MMF geared Condenser.

Type 247 supplied mounted or unmounted, with or without gear.

$5.00 **$3.25 to $7.25**

At your dealers, or direct from us: Two educational folders, "Quality Amplification" and "Quality Condensers." Ask your dealer or write us. Send for free Radio Bulletin 914U.

General Radio Company

Manufacturers of Radio and Electrical Laboratory Apparatus

Cambridge **Massachusetts**

5420

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Natural Re-PRODUCTION

Atlas AMPLITONE

LOUD SPEAKER

No blast or distortion. Its exclusive patented feature — the adjustable, double diaphragm—produces the radio programs in their original naturalness. Tuneable to your set and receiving conditions.

Let your ears be the judge. Hear the Atlas Amplitone at your dealer's. Write for interesting booklet "B." **$25**

Letters from Users Requested

What have you accomplished with your Atlas Amplitone? Tell us about it.

Multiple Electric Products Co. Inc.

RADIO DIVISION

ORANGE ST., NEWARK, N.J.

Warren Radio Loop, cut away to show construction

Enjoy Your Set All Summer No Big Aerial Needed

WARREN RADIO LOOP

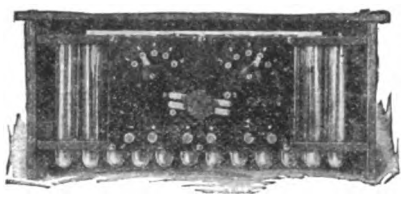
TAKE down your clumsy, dangerous, static attracting aerial and substitute a **Warren Radio Loop.** Flat as an atlas. Smallest size will fit inside your set, making it easily portable. Get the radio programs out of doors, wherever you go, this summer with a **Warren Radio Loop.** Sold by wide-awake dealers everywhere.

A TYPE FOR EVERY SET AT THE BEST DEALERS

Type A-737 (300-700 meters) 6 inches square—non-directional.....$10
Type A-7236 (175-1000 meters) 6 inches square—non-directional.....$12
Type B-2837 (300-700 meters) 18 inches square—directional.....$20
Type BL-2820 (200-15,000 meters) with honeycomb coil. 18 inches square—directional.....$25

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO., Dept. F. Asbury Park, N. J.



KICO Storage "B" Batteries give long service at low cost

Alkaline type, will not sulphate or buckle. Life unlimited. Not harmed by short-circuiting, overcharging, or standing idle. Panel switches afford single cell variations. Easily re-charged from any 110-volt A.C. line by means of small home rectifier. One charge lasts three to six months in detector plate circuit.

Prices without rectifier:	Plain	(With Panels)
16 cell 22 volt	$5.50	
24 cell 32 volt	$7.25	$11.75
36 cell 48 volt	$9.50	$14.00
50 cell 68 volt	$12.50	$17.00
78 cell 100 volt	$17.50	$22.50
108 cell 145 volt	$23.50	$28.50
Unmounted rectifier	$1.00	
Mounted rectifier	$2.50	

SATISFACTION GUARANTEED

All batteries are sold with the privilege of receiving your money back if not satisfied within a 30 day trial. Write for full information on "A" and "B" Batteries.

KIMLEY ELECTRIC COMPANY, Inc.

2667 MAIN STREET BUFFALO, N. Y.

This "UNITED" Audio Frequency Amplifying Transformer

is a little "gem" of radio engineering — magnetically shielded. Ratio 5 to 1 — a wonder-worker in producing loud, clear-toned signals, from any distance. At your dealer's, $4.50.

"United" Variable Condensers have a new vernier dial assembly, original with us, that makes fine tuning a joy.

43 plate..$6.50	11 plate..$5.50	3 plate..$4.75
23 plate.. 6.00	5 plate.. 5.00	Postpaid

Vernier alone; can be attached to any plate condenser by drilling one hole **$2.50**

Show this ad to your dealer and ask him to supply your needs at the above prices. If he cannot do so, remit to us direct, under our money-back guarantee and give us name and address of dealer you wish to favor.

UNITED MFG. & DISTRIBUTING CO.

9705 Cottage Grove Ave.
Chicago, Ill.

New York Office:
50 Church St.
New York, N. Y.

San Francisco Office:
709 Mission St.
San Francisco, Cal.

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Music Master
RADIO AMPLIFIER

Completes RADIO

MUSIC MASTER brings you *full* enjoyment of things broadcast.

The warm, human tones of the 'cello, for example, are revealed through MUSIC MASTER with all their expression and delicate coloring—only audible when the musician *himself* plays.

MUSIC MASTER does not influence the music's original quality but simply diffuses it in its true brilliance and richness. No tone-twisting!

A radio revelation! Allow your dealer to demonstrate MUSIC MASTER to you so you may make comparisons. This test never fails to establish MUSIC MASTER'S *pre-eminence.*

14″ Horn, for the Home $30
21″ Horn, for Concerts $35
Comes Complete, ready to attach in place of headphones

JOBBERS DEALERS **A MUSIC MASTER will be sent you with full privilege of return. Write for full description of the GERACO Line and prices.**

GENERAL RADIO CORPORATION
Makers and Distributors of High-Grade Radio Apparatus

CHICAGO **PHILADELPHIA** **PITTSBURGH**
S. W. Cor. 10th and Cherry Streets

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Patent Applied For

THE FAVORITE RADIO CABINET makes a high class Radio Instrument.
It operates any good hook-up.
With one vacuum tube it operates a loud speaker.
No loop, no aerial, no ground, or other attachments necessary. It fills all vacancies.
THE FAVORITE has won the heart of the nation.
Everybody who see it, want one and those who have the price, buy one.
It is a beautiful piece of household furniture and adds to the appearance of the finest home.
A FAVORITE in operation on the floor of a dealer attracts all the attention of his customers.
Write for descriptive matter and prices.

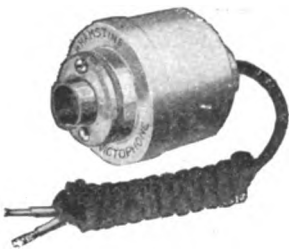
Manufactured by

G. A. BARTHOLOMEW

409 Guardian Bldg. Cleveland, Ohio

RHAMSTINE*

Victophone



$7.50

Complete with cord

The quick popularity attained by the *Victophone* attests both the real need of a quality receiver built specially for use with the phonograph and the unexcelled tone and volume of this latest product of the Rhamstine* shops.

You'll like your Victophone.

Manufactured by

J. THOS. RHAMSTINE*

2162 E. Larned Street Detroit, Mich.

***Makers of Radio Products**

Coils and mountings licensed under DeForest patents

Insist on the Genuine

Ask Your "Old Timer" Radio friend why sets using Honeycomb Coils are best.

Then ask your dealer for Branston Lateral Wound Honeycomb Inductance Coils and Coil Mountings.

Branston Coils are protected from injury and can not come loose from mountings. Positive contact assured. Guaranteed uniform maximum inductance with minimum distributed capacity.

Send 2c in stamps for Series 1 "Hook-Up" Circular showing five good Honeycomb Coil hook-ups and Catalog of Famous Branston Radio materials. Write today. Give us name of your Radio Dealer. If he can't supply you, let us know.

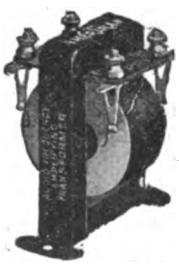
Chas. A. Branston, Inc.

811 Main St. Buffalo, N. Y.

In Canada—Chas. A. Branston, Ltd. Toronto, Ont.

In the new Cockaday circuit, note

The AMERTRAN



It is also the standard audio transformer for the best NEUTRODYNE and REFLEX circuits. Its use is not limited to any particular audio circuit or with any particular tubes.

Price $7
Ask your electrical dealer, or sent carriage charges collect. (Wt. 1 lb.)

For **pure tone quality** with **maximum volume,** The Amer-Tran audio transformer has no equal.

Turn ratio, 5:1

Amplification ratio is from 30-40 times audibility in a flat-top distortionless curve.

American Transformer Company

Designers and builders of radio transformers for over 20 years.

175 Emmet St., Newark, N. J.

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Radio "Blind-man's Buff"

Picking your program with a single circuit receiver is a whole lot like playing blind-man's buff. You're not sure what you'll catch—nor how long you'll hold it.

In the midst of the entertainment you selected some other broadcasting station is quite likely to cut in and spoil the fun.

Selecting your radio equipment with your eyes open avoids this nuisance of jamming and scrambled messages.

Any radio-wise amateur will tell you that there's no comparison in genuine satisfaction between a single circuit instrument and the Paragon three-circuit receiver.

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its great superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that with a Paragon receiver you get what you want when you want it—complete messages and clear music from the station you tune in on, without interruption and jamming. Until you have listened in with a Paragon three-circuit receiver, you cannot guess the real pleasure and fascination of radio.

Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

Also Manufacturers of PARAGON	
Radio Telephone Transmitters	Amplifier Transformers
V. T. Control Units	Control Dials
Rheostats	Amplifiers
Potentiometers	Receivers
V. T. Sockets	Switches
Detectors	Variometers

Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier—$50.00
(Licensed under Armstrong Patents.)

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Your Choice!
—for Only 22 Cents in Stamps!

Hundreds of reliable hook-ups and circuit diagrams—practical hints and handy knacks—money-saving tips and pointers on how to make and improve your own sets. Take your pick of all this authoritative information on radio!

PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

There are still a few copies left of each of these back issues —with the exception of January, 1923. *While they last* you can take your pick of them at only 22 cents each, to cover cost and mailing. Here's your opportunity to complete your files of POPULAR RADIO and to add to your store of information on just the subjects which interest you.

Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

May, 1922

—Harnessing waves to wire.
—How to make and install your own Receiving Set.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How to use your Radio Set in summer.
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.
—How to use your Phonograph as a loud speaker.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—Radio on your pleasure boat.
—How to make a variable condenser.
—The foolish fear of lightning.

September, 1922

—How to build the Armstrong Circuit Receiver.
—How the Vacuum Tube works.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How the crystal detector detects.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—Tricks with high frequency electric current.
—The most popular transmitting aerial.
—Right and wrong ways of adjusting the Regenerative Receiver.
—How to make a novel variocoupler.

December, 1922

—Radio on your motor car.
—How to select the best coil for your set.
—How to make and use a loading coil.
—How the Vacuum Tube detects.
—A Receiving Set that takes notes.
—How to make a series-antenna condenser.

January, 1923

(This issue, in which appeared Mr. Cockaday's full description of his "DX" Regenerative Receiver is completely exhausted. A circuit diagram of this 3-Circuit Tuner is found, however, in the Question and Answer Department of the April issue, 1923.)

February, 1923

—20 tips on tuning.
—The Hoffman measurement charts.
—Shall I use a "hard" or "soft" tube?
—A novel tuner for shutting out interference.
—How the Audio frequency amplifier works.
—Pointers on aerials.
—How to add an Audio-frequency amplifier.

March, 1923

—Making moving pictures talk.
—A Receiver without batteries.
—What really guides Radio waves.
—How to get the greatest efficiency out of your Radio circuits.
—How to make a one or two-step Audio-frequency Amplifier.
—How to make a Multi-Layer Coil.

April, 1923

—Ether waves and the Einstein Theory.
—How to use Regeneration without Radiation.
—How to make a crystal detector from a spool.
—How the Vacuum Tube detects and rectifies.
—How to make a simple single tube Receiving Set.

May, 1923

—Four ways to get good modulation.
—How the Radio frequency amplifier works.
—A simple buzzer test.
—How to make a light contact detector.
—How to build your own wavemeter.
—How to build the Cockaday 4-Circuit Tuner.

June, 1923

—How to use your Radio Set on your vacation.
—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.
—How to determine the constants of your antenna.

July, 1923

—How to install your Radio Set on your boat.
—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

POPULAR RADIO, INC.

9 East 40th Street **Dept. 84** **New York City**

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AUDIOPHONE AND CANOE
both go to camp

Nobody wants to wear head phones during hot, stuffy weather. A small efficient Loud Speaker ruggedly built will be welcome in any camp outfit. The AUDIOPHONE JR. is just the thing.

Bristol AUDIOPHONE made in two sizes—

Audiophone Sr.
Diameter of horn, 15 inches
Weight, 10 pounds
Price, $32.50

Audiophone Jr.
Diameter of horn, 11 inches
Weight, 7 pounds
Price, $22.50

Light in weight and easily assembled or dismantled without tools. Doesn't require any battery. The tone quality is exceptional and will give enough volume to entertain the whole camp party.

See it at your dealers or write direct.

Bulletin 3006-L describes them.

THE BRISTOL COMPANY
Waterbury, Conn.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH DETROIT
CHICAGO ST. LOUIS SAN FRANCISCO

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F-F BATTERY CHARGER

CHARGES RADIO "A" & "B" & AUTO STORAGE BATTERIES at HOME Overnight, for a Few Cents From Any 100 to 130 Volt 60 Cycle A. C. Lamp Socket.

All TYPES But "B" Charge AUTO Batteries Overnight Right In Your CAR

$15

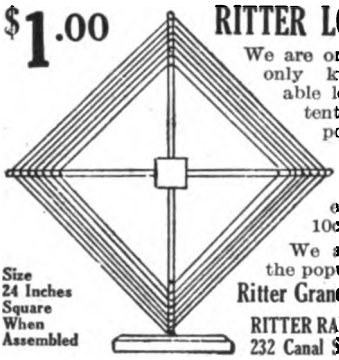
CHARGES RADIO & AUTO BATTERIES.

F-F AUTOMATIC MAGNETIC TAPER CHARGE DESIGN made BATTERY CHARGING POPULAR. Eventually You Will Buy An F-F CHARGER & The Sooner You Buy One; The More You Save. A-B Charges All 6 Volt & up to 120 Volts Of "B" & Loud Speaker Storage Batteries In Series Inductively At Home Overnight. Disconnecting & Multiple Connections Unnecessary. Charging Circuits Separate. No Chance For Grounds, or Short Circuits. Nothing To Slop Over, Be Filled, Burn Out, Need Attention Or Cause Trouble. Infusible Rectifying Brushes Maintain Constant Efficiency Uninterruptedly. COMPLETE PORTABLE AUTOMATIC. No Skill Required. AMMETER eliminates Guess Work. Nothing Like It Made. Lasts A Lifetime. Screw Plug In Lamp Socket; Snap CLIPS on Battery Terminals; Turn Switch & Battery is Charged In Morning. Charged Batteries Mean Fewer Expensive Replacements. It Costs Less To Buy An F-F CHARGER Than To Be Without One. INSIST on The F-F CHARGER Built By A Master Of The Art In 7 TYPES. Thousands Sold Make Possible These POPULAR PRICES: Type 6 charges 6 Volt Battery At 6 amperes $15 Type 12 charges 12 Volt Battery At 5 amperes $15 Type B charges Radio "B" Batteries Upto 120 Volts $15 Type A-B Is Combination Of 6 & B $20 Type 166 charges 6 Volt Battery At 12 amperes $20 Type 1612 charges 12 Volt At 7 amps $20 Type 1626 Is a Combination Of Types 166 & 1612 and Charges Both 6 & 12 Volt Batteries $28 Types B & A-B are RADIO Specials. Types 166, 1612 & 1626 are For Heavy & Rapid Charging. SHIPPING WEIGHTS Complete with AMMETER & BATTERY CLIPS 11 to 15 lbs. PURCHASE from DEALER; Mail Check, or WRITE us to Ship TYPE desired C. O. D. ORDER Now, or WRITE Immediately for FREE Descriptive CHARGER Bulletins 44 & 44A.

FRANCE MFG. CO., Cleveland, Ohio.

$1.00

RITTER LOOP AERIAL



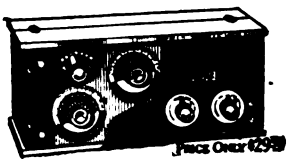
Size 24 Inches Square When Assembled

We are originators of the only knockdown portable loop aerial. Contents: wire, binding posts, wood parts and instructions on how to assemble and operate. By mail 10c extra.

We also manufacture the popular

Ritter Grand Crystal Set $3.50

RITTER RADIO CORPORATION
232 Canal Street, New York City



MIRACO GETS 'EM 1500 MILES AWAY

At this low price you get the efficiency of a $50 set. It is a two tube radio frequency receiver—picks up stations 1500 miles away under good conditions—everywhere—any time. This outfit can be operated with a dry cell or storage battery. Cabinet is of solid mahogany and workmanship the finest throughout. Order direct or send for new Bulletin.

DEALERS—write for proposition—it's a winner.
AGENTS—wanted everywhere—write for territory QUICKLY

THE MIDWEST RADIO COMPANY
812 Main Street Cincinnati, Ohio

POSITIVE RESULTS

are being obtained by thousands of satisfied users of the

EASTERN COIL SETS

for the

COCKADAY CIRCUIT

The remarkable features making this circuit more popular each day are its simplicity of construction and control—wonderful selectivity—distance records—clearness and loudness of reception, and the fact that all capacity squealing, interference, etc., are eliminated.

Made as per specifications of Mr. Cockaday, using No. 18 wire with D coil bank-wound.

Complete set of B, C & D coils—Price $2.75.

Hook-up directions and material list furnished free with each set of coils.

Mail orders filled. Dealers communicate.

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WHY PAY MORE

GENUINE TUBES

W. D.-11 **5.95** UV-199
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All New. No Stamps. Checks. C. O. D.

Send for our new price list with hundreds of other items.

Save money. Order from us.

Cut Rate Radio Co.

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MPM — MILLION POINT MINERAL — THE WORLD'S GREATEST RADIO CRYSTAL

GIVE YOUR CRYSTAL SET A FAIR CHANCE

A Crystal Set, when properly equipped, is the ideal method of radio reproduction—clear, musical, economical. But the best crystal set ever made will not reproduce properly with a poor crystal.

M. P. M. (MILLION POINT MINERAL) CRYSTAL

has made the Crystal Set successful. Unsolicited testimonials are constantly being received, reporting records up to 1200 miles. Don't discard your Crystal Set until you have given "M. P. M." a trial.

Send 25c and name of your radio dealer for sample unmounted crystal. 35c for mounted. Insist upon M. P. M.

M. P. M. SALES CO., Dept. PR, 247 So. Central Ave., Los Angeles, Cal.

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More Reasons Why

CROSLEY

Better-Cost Less Radio Products are *so Much Better*

BY perfecting the new Crosley Duostat universal filament control rheostat, the Crosley Manufacturing Company has made giant strides in bringing within reach of all, the true reproduction of signals from the air. This rheostat (patent pending) properly controls all makes of tubes, including the new "A" and 199 and makes Crosley instruments even more efficient than ever before because of the:

1. Efficient, smooth, uniform control of all tubes duo-wound to low and high resistance 10 to 20 ohms.
2. Plunger type contact actuated by a special spring, insuring uniform pressure at all times.
3. Spring washers producing uniform tension.
4. Positive rugged stop at zero resistance or "on" position.
5. Circuit interrupted at "off" position.
6. Resistance material having zero temperature co-efficient.
7. Windings protected by a black moulded shell of high heat insulating material.
8. Electrical connections substantial in construction.
9. Design of parts to prevent warping.
10. Extremely low operating temperature with all tubes.

The outstanding performance of all Crosley instruments is due to the effective co-operation of the new filament control rheostat with the other parts.

The new Crosley Duostat universal duo-wound rheostat for all makes of tubes is sold separately from Crosley radio sets if desired, complete as shown in the illustration above. Price—85c.

For Sale at Best Dealers Everywhere

Write for free Catalog

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New York Office, C. B. Cooper, 1803 Tribune Bldg., 154 Nassau St.
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St. Louis Office, Robt. W. Bennett Co., 1326 Syndicate Trust Bldg.

Crosley Radio Receivers have a universal appeal. The Model X pictured here is the last word in efficiency. It sells at $55 in spite of its new features and advanced manufacturing cost.

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has given us many things to admire and use. But it requires "man made" devices to manifest the greatest wonders. For instance, RADIO.

In the Service Radio receiving set beauty and utility are exemplified in their highest form.

It adds beauty to your home and enjoyment through its loud, clear reception of distant music, speeches, etc.

The story of SERVICE RADIO will be told serially in this publication—or, if you prefer the entire story, write us for booklet, "The Story of Service."

SERVICE RADIO SETS

are simple to operate. They are made by a new concern composed of engineers and executives who have been connected with the most progressive producers.

Dealers: write for prices, terms and territory. Dealers' names will be published in our advertising.

"This Is a TELEFORCE Product"

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4727 Montgomery Road
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Make Your Set The Sensation of Your Town!
with

The RADIOXOR

Simple—Inexpensive—Certain

Can be attached to any set, operating head phones or loud speaker,—crystal or Vacuum Tubes,—Loop, Plug or Outdoor Aerial.

Send your name, address and type of set on a post card for details.

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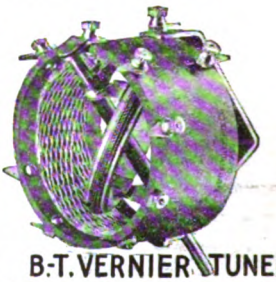
B-T Universal Vernier Tuner

Replaces tapped coils and switches in the Reinartz and Ultra Audion Circuits, and improves reception wonderfully.

Takes the place of variocoupler in regenerative circuits with marked improvement in results.



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Adapted equally to all the old and new circuits.

Ask your dealer or remit direct, sending dealer's name.

FREE Photo diagram of new B-T Reinartz hook-up. Send 2c stamp or postage and name of your dealer.

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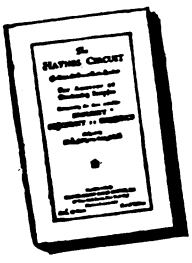
A. J. HAYNES
Assoc. Institute of Radio Engineers

MR. HAYNES has made many notable contributions to radio—among them the now world-famous Haynes Circuit. In this circuit Mr. Haynes answered for the first time in the history of radio the insistent demand for extreme long distance range at a reasonable cost. Employing only well known and proven principles of radio, but in a combination never before used, he has secured a most remarkable degree of selectivity and simplicity in operation.

Mr. Haynes' circuit has met with the enthusiastic approval and endorsement of the country's leading experts and amateurs. It is the first circuit on which any designer has been able to give an unqualified promise of 1,000 miles range.

Radio enthusiasts will find Mr. Haynes' booklet, describing his own personal receiving set, of absorbing interest and extremely helpful. Full diagrams and illustrations—and a complete description of how he came to build it, what he found out, and the surprising results obtained. Sent postpaid upon receipt of 50c.



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Designed by A. J. Haynes, Originator of the Haynes Circuit

OWNERS of radio sets located close to one or more broadcasting stations often find it impossible to eliminate entirely or to tune-out these stations. When nearby stations are operating they come in so strong as to drown out or interfere with programs from more distant stations.

The Haynes Selector was designed to eliminate this troublesome annoyance. Its success has been established beyond shadow of a doubt. In New York City with eight active broadcasting stations, thousands of users have found the Haynes Selector the final solution to all their interference troubles.

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The secret of the Haynes Selector lies in the special filter coil—never before used in any wave-trap. The interfering station is quickly and entirely trapped-out before it ever reaches your receiving set, ***and without the slightest loss in volume or signal strength*** of the station you wish to hear.

Haynes Selector wired, showing Filter Coil

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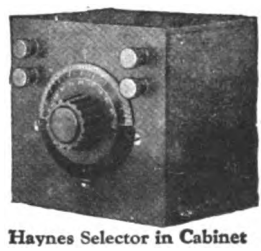
The Haynes Selector can be used with any type of receiver—single or double circuit—any type of antenna or loop aerial. Two or more Haynes Selectors may be used in series and all local stations eliminated successively. You can then work through to long distance with an unparalleled degree of selectivity. No knowledge of radio required for its use. ***You can connect it to your receiving set in an instant's time.***

Complete in Cabinet Postpaid **$8.50**



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Be Sure to Send for Leaflet

Send a two-cent stamp for our 4-page illustrated leaflet giving in complete detail the many uses of the Haynes Selector, hook-ups, diagrams, theory and directions for use. We will be glad to mail these leaflets as long as supply lasts to readers of Popular Radio. ***Send two-cent stamp today.***

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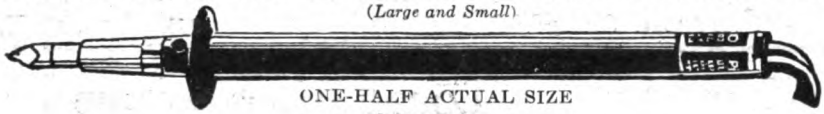

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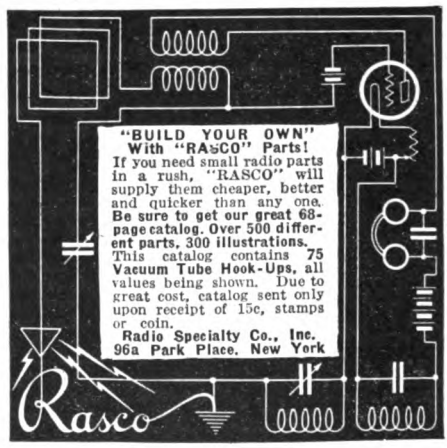
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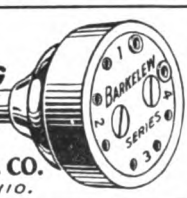
for

STANDARD JACKS



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The new Tuska Popular. Armstrong Regenerative Circuit, 3-tube, two dials tuning. Long range. Steamship officer reports hearing U. S. stations 2400 miles away clearly. Others $35 to $200. Ask for catalog.

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TUSKA RADIO

Worth Sending For!

Circular describing Rheostat construction is sent free of charge upon request. Explains cut-out switch, constant contact principle, and minute adjustment of UNITY Vernier Rheostat. Write for it *now*.

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Manufacturers of

Ultra-fine Receiving Sets

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Let Radio Experts Buy for You

This Service Is Free

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The Boys Are the Buyers

Who has made radio an epidemic throughout the country? Who tinkers and fusses with sets, dismantling them and reassembling them, trying to better them? Who wants to learn all the latest improvements in radio equipment? Who buys most of it? The boys.

It's the boys who are spending the money. Every nickel goes for head sets, tubes, batteries and switches, When the price of the desired object exceeds their means, do they quit? Not a chance. They get to work on their parents and keep at it until they come across. That gets the grown-ups interested, and they go to their sons for information and advice.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

reaches this boy market as no other medium can. Over half a million boys, averaging from 15½ to 16 years of age, read it from cover to cover every month. Especially the radio department edited by Armstrong Perry, the world-known expert. It gives them the kind of stories and articles they like. From it they learn a surer and finer appreciation of values—personal and commercial. Because it has always played square with them it holds their confidence—particularly in its advertising.

Readers of THE AMERICAN BOY are the leaders of their gangs. And what these leaders do is done by the rest of the bunch; what they approve is right; what they buy, the others want.

Advertising in THE AMERICAN BOY is not only the logical way to reach boys—it's the only direct way. By winning their approval of your product you not only increase your present sales. You start a habit of buying your goods that lasts as long as you give them a square deal.

Copy received by August 15th will catch the October issue.

THE SPRAGUE PUBLISHING COMPANY, Detroit, Michigan
(Member A.B.C.)

Advertising Manager
548 Lafayette Boulevard

Branch Offices **286 Fifth Avenue, New York**
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"How I Located My Trouble"

A Massachusetts radio enthusiast tells of a happy discovery that finally solved his difficulties.

"I COULDN'T figure out what was wrong with my radio set," states a Fitchburg business man whose experience is interesting because it shows how one simple little adjustment will sometimes make such an amazing improvement in results.

"I had erected my antenna in just the right way, had connected up my different parts with the greatest care, had added improvements that were designed to bring my apparatus to the highest possible perfection," he continues.

"I spent a good many hours talking over my problems with dealers and experts. I followed one suggestion after another. But still the same old trouble!"

Do You Have This Trouble?

"In spite of all my efforts, when I wanted to hear some particularly interesting broadcasting program, other stations kept breaking in; I found difficulty in getting long distance points; and intermittent squeals, whistles and howls would persist, no matter how I tuned or adjusted my dials.

"I was pretty nearly convinced I'd have to get some high-priced installation man to come out to my home and set me right, when purely by chance I happened to pick up a copy of POPULAR RADIO—and thumbing through its pages I found the very answer to my problems!

"There in black and white, diagrammed and explained, was a simple, practical suggestion that turned the trick for me."

The One Best Way to Get Results

Many other radio enthusiasts, too, who want to get the **most** out of their sets have found in POPULAR RADIO many an idea and practical suggestion that has made a world of difference in their enjoyment of this fascinating pastime, and saved them hours of experiment and costly error.

If you don't already *subscribe* to POPULAR RADIO, don't miss this opportunity of getting the magazine regularly at your permanent address.

A year's subscription will **save you money** over what you would pay on the newsstands, and will bring you the magazine every month, rain or shine.

Your Questions Answered *FREE!*

Then, too, as a regular subscriber, any questions you wish to ask of the Technical Editor will be answered **free of charge.** This is one of the most valuable features of POPULAR RADIO's service, and is the same service for which non-subscribers pay 50 cents for each question asked, and they say it's worth many times what they pay. *Yet you can get this same added service absolutely free.*

The Coupon Entitles You to This Service

Simply fill out and mail the attached coupon today and your subscription will start with the very next issue. If you have some problem to put up to our Technical Editor now, send in your question with the coupon and he will be glad to straighten you out. This is a privilege to which all subscribers are entitled, and we want you to take full advantage of it.

But do not delay sending in your subscription. Get POPULAR RADIO regularly each month and don't risk missing any of its scores of helpful and practical suggestions.

POPULAR RADIO, Dept. 80,
9 East 40th Street, New York City

Please put me down for a year's subscription to POPULAR RADIO, beginning with the September issue. I am enclosing $2 in full payment which also entitles me to free use of your Question and Answer Department.

Name .....

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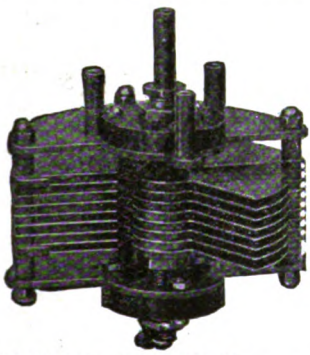
SE-AR-DE

SOME OF THE PARTS SPECIFIED BY MR. COCKADAY IN HIS FOUR CIRCUIT TUNER



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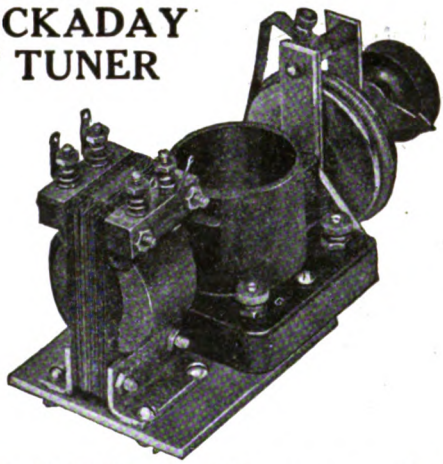
CAP. .00035 M. F. 17 PLATES



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Super-Sensitiveness!

THE crystal is the "bull's-eye" of your crystal receiving set. Unless it is super-sensitive you are wasting time and entertainment and cannot "hit" the combination for best results. Insist upon the genuine original Arlington Tested "NAA" Detector Minerals. They are carefully selected from bulk stock, individually tested and guaranteed super-sensitive.

Galena, Silicon or Goldite price per crystal, 25c. Same mounted in brass cup, 40c. Obtainable at your dealer's or sent direct (post-paid) on receipt of price.

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I will train you, quickly and easily, to design, construct, install, operate, repair, maintain, and sell all forms of Radio apparatus. My new methods are the most successful in existence. Learn to earn

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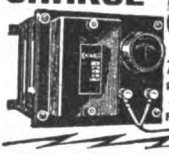

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"A Laboratory Product"

THIS new dry battery for the "A" or filament circuits of dry cell vacuum tubes is a Burgess achievement which will not soon be forgotten.

Burgess has perfected a dry "A" battery which will give over twice the life, on vacuum tube service, of any ordinary No. 6 Ignition dry cell. It has a rapid recovery to high voltage after short periods of rest and practically no voltage lost when not in use.

This Burgess "A" dry battery will lead the "A" battery field just as the Burgess dry "B" battery has led the field of "B" Batteries. Ask any Radio Engineer about Burgess "B" Batteries.

Made only in single cell units. This makes it possible to wire up convenient combinations for all types of dry cell tubes, and eliminates the hazards and expense of multiple cell units.

Ask for the Burgess "A" Battery

when you are equipping your new set or replacing your old dry batteries. Sold by all progressive radio dealers.

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Radio's New Marvel

At Last Static Overcome

UNLIKE any other type of Antenna it *will not* bring in static and other outside interferences. Consequently your reception will be clearer and sweeter than ever before. *And it will make your set portable.*

The Short Cut Antenna will do away with and work better than an aerial—or cumbersome indoor loop.

The Short Cut Antenna does not even require electric light plug connections. Being absolutely non-directional, it will operate in any position.

It can be attached easily and quickly to any tube set. This time-tested, patented Short Cut Antenna is truly Radio's new marvel.

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Send the coupon for one. *You risk nothing.* Test it out under the most adverse weather conditions. In case the Short Cut Antenna does not do all we claim it will do—send it back and your money will be refunded immediately.

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Short Cut Radio Corporation
Dept. C435
243 West 54th Street, N. Y. C.

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Rush a Short Cut Antenna to me. I will pay $5.00 to the Postman. In case it is not absolutely satisfactory, I will return it—and you are to refund my money.

I have a .....set.

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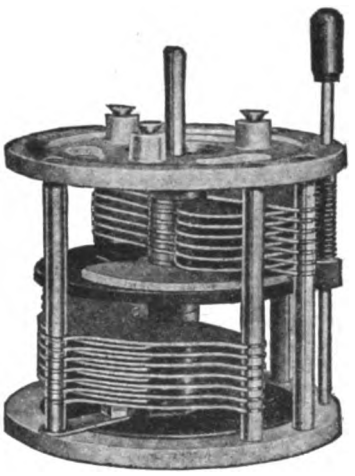

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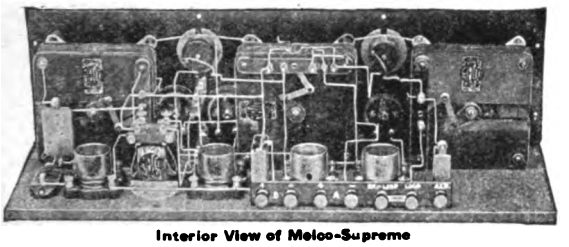

Interior View of Melco-Supreme

employing the Acmedyne Circuit developed and perfected by Mr. L. L. Jones, Radio Engineer.

THE MELCO-SUPREME
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has as its principal features:

1—Telos Variometer
2—Telos Vario-Transformers
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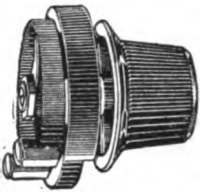
Operation is simplicity itself—no aerial or loop needed, merely a 10-foot wire. By covering all broadcasting ranges from 175 to 750 meters, wonderful program selectivity is assured.



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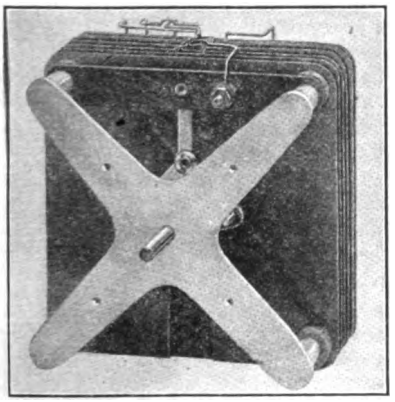

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Good news for the radio fan

Announcing a complete line of Exide Radio Batteries for all types of tube sets

EVERY radio fan who has tuned in with an Exide A or B battery will welcome the news that the popular Exide line has been extended to include two low-voltage A batteries. An Exide Radio Battery is now available for all types of vacuum-tube sets.

Whether you want a long-life storage battery for six-volt tubes, an A battery for low-voltage tubes, or a B battery, you can take your choice of Exide Radio Batteries and be sure of getting the right battery for your set.

For low-voltage tubes

The two newcomers in the Exide radio family are two- and four-volt A batteries for tubes consuming .25 amps. at 1.1 to 1.5 volts and those using .06 amps. at 3.0 to 3.5 volts. These sturdy little batteries were specially designed to meet the requirements of WD-11 and UV-199 vacuum tubes. Weighing less than 6 lbs. each, they are midgets in size, but giants in power.

Exide Radio Batteries give steady, dependable current with only occasional recharging. They make it possible for you to reproduce broadcast selections in clear, bell-like tones. When your set is hooked up with an Exide, you have ample power for maximum signal strength at all times. You can tune in distant stations with the most satisfactory results.

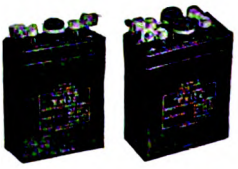
In service over a generation

For more than a generation the famous Exide Storage Battery has helped to turn the wheels of industry. Long before radio broadcasting achieved its present popularity, the Exide proved its worth in commercial and marine wireless; it is used today in a majority of all government and commercial wireless stations. When the American public found in radio a new form of entertainment, the Exide became by reason of superiority the leading radio battery.

You can get an Exide Battery from a nearby radio dealer or Exide Service Station. Ask the dealer for booklets describing in detail the complete line of Exide Radio Batteries, or write direct to us.

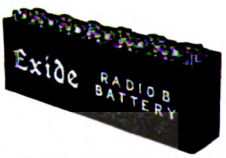
For six-volt tubes

Like all Exide Storage Batteries, the Exide A Battery for six-volt tubes is dependable and long-lasting. It is made in four sizes, of 25, 50, 100 and 150 ampere hour capacities.



Two- and four-volt A Batteries

The new Exide A Batteries consist of one and two cells, respectively, with rated capacities of 12 and 24 ampere hours. The two-volt A Battery will heat the filament for 96 hours; the four-volt A Battery for 200 hours.



Exide B Batteries

give noiseless, full-powered service over a long period of discharge. Designed throughout to prevent electrical leakage. Capacity, 3 ampere hours.

Exide
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Service Stations Everywhere **Branches in Seventeen Cities**

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The Ideal Tube for the Call of the Open

A Specially Designed Tube For Every Radio Use

Are you spending your vacation in the North Woods—at the seashore—in one of our many great national parks, or are you motoring across country? In any event the new Cunningham dry battery detector and amplifier, type C-299, makes it possible for you to take a radio receiver, which will be light in weight, compact in design, and highly efficient in operation. It is the special filament in this tube, having a current so low that it may receive its supply from standard No. 6 dry batteries or even from ordinary flashlight batteries, that makes possible this new and interesting application of radio.

The receiving set you now have can be readily adjusted to use this new tube and be a source of use and pleasure on your vacation trip. In any event your dealer can give you useful suggestions for the purchase or construction of a highly efficient and practical portable set.

Patent Notice: *Cunningham tubes are covered by patents dated 11-7-05, 1-15-07, 2-18-08, and others issued and pending. Licensed for amateur, experimental and entertainment use in radio communication. Any other use will be an infringement.*

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Light enough to carry with you. Powerful enough, with its Radiotrons WD-11—detector and one-step amplifier—to listen in from farthest mountain top camp to the big cities. Neat—and finely finished, as every Radiola is. What a summer of fun it means!

Are you listening in to
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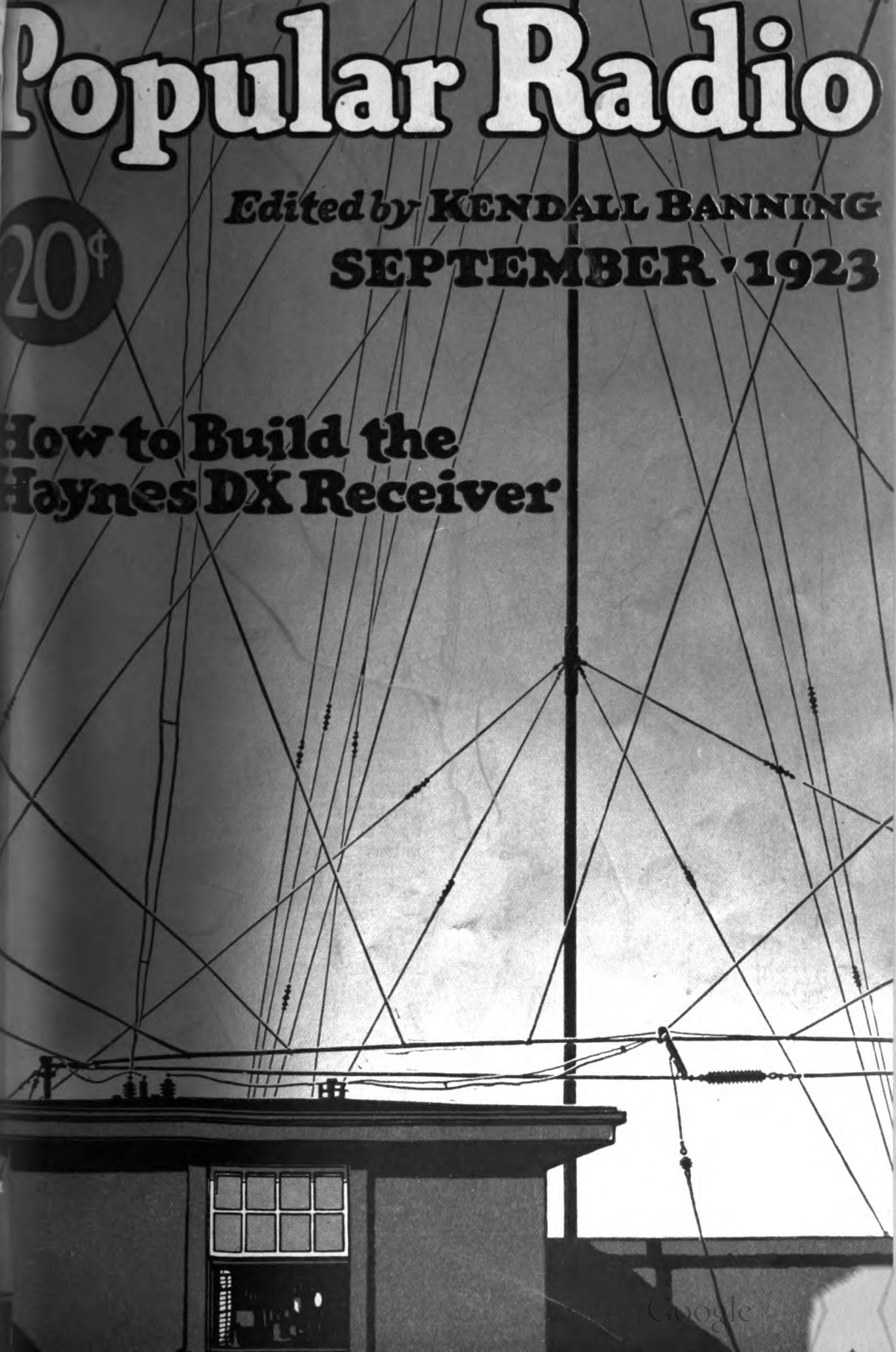
Popular Radio

Edited by KENDALL BANNING

20¢

SEPTEMBER · 1923

How to Build the Haynes DX Receiver



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The standard base dry cell tube, $6.50

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Radiotrons

To Get Distance— and Get it Clearly

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This we pass on to the consumer in lowered prices. The standard of Brandes quality will ever be maintained or raised if possible—checked by twenty-two rigid tests and inspections of each headset.

NEW PRICES
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Made in Canada and England by
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Matched Tone

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Radio Headsets

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(Cover design by Frank B. Masters)

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This Receiver employs Regeneration and Tuned Radio Frequency Amplification with only two simple tuning adjustments.

Write for
"Seven Points of Satisfaction"

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PAGES WITH THE EDITOR

THE Editor takes pleasure in here announcing a long-contemplated and carefully-planned move that will not only vastly benefit our readers but that will establish POPULAR RADIO in a class by itself among the radio magazines:

Beginning with the November number, POPULAR RADIO *will be enlarged by 56 pages.*

* * *

THIS substantial increase—(which is almost equivalent to the size of the entire magazine eighteen months ago)—has been inevitable for several months, owing to the increasing obligations of publishing the very latest and best information concerning the radio art and electrical science while that information is new and while our readers can get the fullest benefit from it.

* * *

THIS enlargement (equivalent to about 40 percent) will enable the Editor to include many valuable articles which have been deferred from time to time only because of the lack of space; also (and more particularly) it will enable him to broaden the editorial scope of the magazine so that it will hereafter include many notable features, including new developments, that will add immeasurably to the interest and importance of POPULAR RADIO.

* * *

THIS forward step will be accompanied by an increase in price from 20 cents to 25 cents a copy on the newsstands—and the yearly subscription price will advance to $3.00.

* * *

AND it will be further accompanied by a circulation guarantee—for the protection of our advertisers—that establishes POPULAR RADIO as having "the largest *guaranteed* circulation of any radio magazine."

* * *

EVERY once in a while the Editor gets a letter that makes him realize even more keenly the astonishingly far-reaching effects of the material that is published in our pages; even an obscure little item tucked away in one of the departments may lead to important consequences that could not possibly be anticipated.

* * *

THE Editor has only recently learned, for example, that one of the largest industrial concerns in the country abandoned plans for a long and costly series of experiments with certain electrical apparatus, as the direct result of an article that appeared in POPULAR RADIO some months ago—an article that was written by one of the foremost scientists of the world, whose investigations indicated that the proposed experiments would be directed along obsolete and consequently futile lines.

* * *

STILL more recently comes this significant letter from Dr. O. I. Hess of Scottsdale, Pa., to whom a short item on page 83 of our July number gave his first understanding of re-radiation:

"The first item in the July number that greeted me," he reports, "was the protest of a radio fan suffering from psycho-asthenia and calling upon the U. S. Government to suppress the single circuit receiver. I have often wondered what might be the cause of the buzzing, whistling and squawking and other interference. Now I know—and the information is worth several years' subscription to your magazine."

* * *

BOTH of these incidents of widely divergent natures emphasize not only the wisdom of insuring the absolute accuracy of every item that appears in this magazine, but the compelling necessity of it—as a foremost obligation to our readers.

* * *

"IF *you see it in* POPULAR RADIO, *it's so!*

* * *

"A BUSINESS friend who has POPULAR RADIO come to his office," writes a friend in Chicago, "told me that the only way by which he could be sure to preserve his copy to take home in the evening, was to lock it in the office safe during working hours; otherwise some one was sure to walk off with it."

Well, after all, is not the office safe the proper place to keep valuables?

* * *

MORE and more apparent is it becoming that Laurence M. Cockaday's article in our May number, "How to Build the New Four-Circuit Tuner," is noteworthy not only because of the remarkable efficiency of the receiving set which it describes, but also because of its remarkably clear and concise presentation. And when praise comes from the editor of an Esteemed Contemporary, it can hardly be construed exactly as mere flattery.

* * *

"IT is the best prepared and best presented technical article of its kind that I have ever seen," generously admitted the amiable Major J. Andrew White (who is known by radio fans through the country) during a visit to the Editor.

"Praise from Sir Hubert is praise indeed."

* * *

"YOUR Four-Circuit Tuner described in May POPULAR RADIO is certainly a fine one. I built one according to your specifications; it has the world beaten for ease of tuning, minimum amount of static and other outside noises. I cut KPO completely (he's across the bay in Frisco from me) and tune in KFI without hearing KPO. And that's more than a lot of hams are doing around the bay. I get stations 750 miles away like local stuff, and no distortion whatsoever."

—A. S. NIELSEN, (6NA)

* * *

AN inkling of our plans for enlarging POPULAR RADIO was published in our August

(Continued on page 8)

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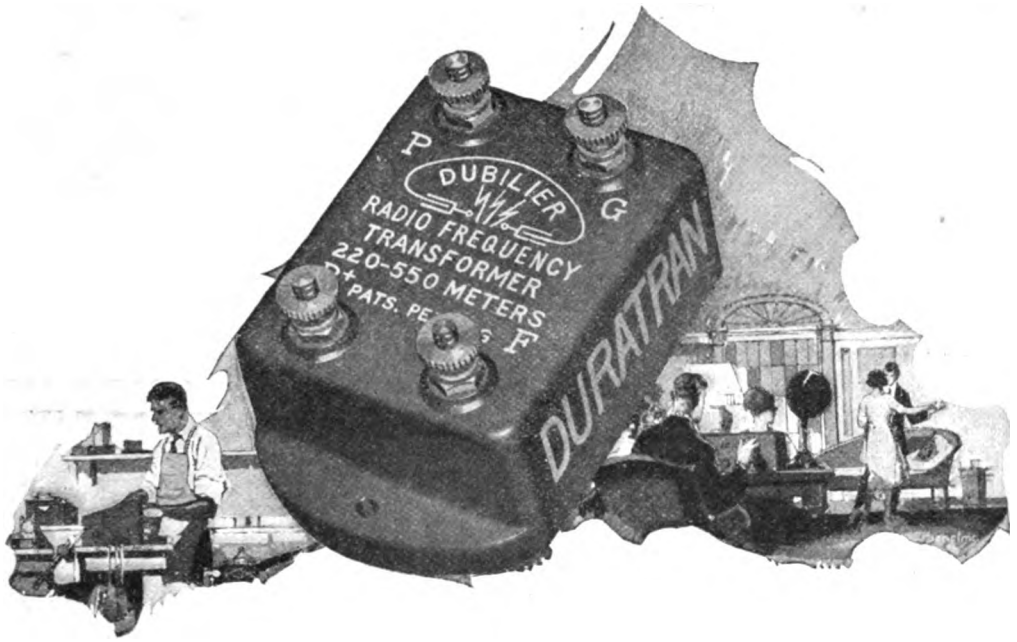

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Amplification on all wavelengths

THE Dubilier Duratran is the supreme radio-frequency transformer. It amplifies powerfully and uniformly *over all the wavelengths* now used by broadcasting stations.

Price $5.00
At all good dealers

DUBILIER CONDENSER AND RADIO CORP.
48-50 West Fourth Street, New York

DUBILIER DEVICES

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PAGES WITH THE EDITOR

(Continued from page 6)

issue, which had no sooner reached the newsstands than the Editor began to receive letters from enthusiastic readers who wrote, in effect, "Go to it!" The very first letter, indeed, came from Waterville, Maine; it reads as follows:

"I notice in the August issue that mention is made of the fact that the size of the magazine is liable to be increased. Go ahead! It will be the best thing that could be done. As long as this dandy radio magazine keeps up the way it has been going in the past, it will always be the leader in the radio magazine field. Keep us amateurs filled with the dope we need, and you'll always have plenty of friends!"

—D. GILBERT LIBBEY

* * *

JUST as this number of POPULAR RADIO is going to press our Advertising Manager was offered a contract for $1,800 worth of advertising—with the proviso that we publish in our editorial pages a press agent "write-up" that accompanied it. The contract was not accepted.

* * *

THIS incident (which is merely one of many of the same nature) gives the Editor the opportunity of defining one of the fundamental editorial policies which is perhaps the most significant of all, and to which the quite remarkable growth in circulation of POPULAR RADIO may be attributed.

The editorial columns of POPULAR RADIO *are not for sale!*

* * *

EVERY article, every paragraph, every picture—every bit of information that appears in our editorial pages—is selected carefully with a definite purpose; to give our readers sound, authoritative, practical and interesting information that is entirely without bias and which is independent of any commercial consideration.

* * *

THE Editor believes that his first obligation is to his readers. He believes that any editorial item that is prejudiced either for or against any product or any manufacturer or any dealer or any special interest, *particularly if that bias is determined by money considerations*, is a form of editorial prostitution to which POPULAR RADIO has not and cannot lend itself.

* * *

IN pursuance of this policy POPULAR RADIO has established itself as a publication entirely apart from the trade journals, dealer magazines and similar periodicals whose editorial content is frankly determined in greater or less degree by the advertisers. Such magazines have a perfectly proper and legitimate field with which the Editor has no quarrel. But their circulation and influence are necessarily limited.

In contrast to that policy POPULAR RADIO has established itself as an eminently authoritative, high grade publication that is receiving not merely the indorsement, but the active support of many of the foremost scientists in the world, whose writings seldom appear in print except in the published proceedings of learned societies and of the technical institutes. These scientists appreciate the fact that the editorial contents of POPULAR RADIO are selected solely because of the intrinsic merits of the articles themselves, and not because advertising may or may not be dependent upon them.

* * *

THE Editor will not knowingly publish any article that exploits a patented product that is on the market, or "boost" any manufacturing concern, or otherwise lend himself to the purposes of the press agent who (naturally enough) has a very special ax to grind. The Editor won't do it because he would not be playing fair with his readers nor would he in the long run be serving the interests of the advertiser.

* * *

THE wisdom of this editorial policy is significantly illustrated in POPULAR RADIO'S large and constantly growing circulation, not only among the very best class of radio amateurs and novices, but among scientists and laymen and even among the manufacturers and dealers as well. And the advertiser in POPULAR RADIO is getting the benefits of this reaction and is profiting accordingly.

* * *

The editorial pages of POPULAR RADIO *are not for sale!*

* * *

THE format of POPULAR RADIO—meaning its physical appearance, its illustrations, diagrams and typographical arrangement—is attracting attention in the Old World as well as in this country. From the editor of one of the most conservative and distinguished electrical journals of England, *Brama*, known to scientists throughout the world, comes this pertinent comment.

"We have just received the latest number of POPULAR RADIO, and should like to congratulate you on the style of its production and layout."

* * *

IN the next number—for October—will appear an important article by the foremost radio expert of France, General Gustave Ferrié, of the French Army.

Kendall Banning

Editor, POPULAR RADIO

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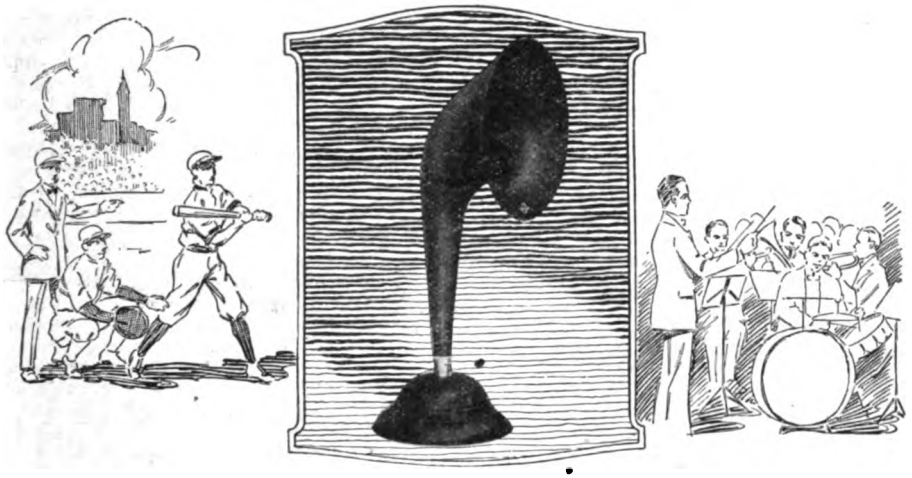
Your Phone Plus a Fibertone Makes a Beautiful Musical Instrument



Entertainment—wherever you may go

***The* FIBERTONE**
is now
$8

Dealers: Write today for information that will lead to greater profits.

FIBERTONE'S price reduction marks a new era in radio. Now the joys of a loud speaker may be yours for the price of an extra pair of head phones. Wherever you may go, entertainment can be extended to the entire household.

Quickly set up by the attachment of just one head phone to the base of the horn. Then—clear, true amplification of every note and word tuned in.

The Fibertone is constructed throughout of fiber to insure against any metallic, vibrative noises to mar its beautiful clear tone. Fiber gives it a sturdiness that permits transportation and camp usage without the least worry. The outer surface of the instrument is finished in an attractive black crystalline.

FIBER PRODUCTS COMPANY
240-C North 10th Street, Newark, N. J.

FIBERTONE

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STRIKING BEAUTY
in this new Kennedy Set

THIS NEW ADDITION to the Kennedy line has a threefold appeal for you. First, its artistic beauty—simple, refined lines. Second, the faithfulness and unusual tonal purity of its reproduction. Third, it is a self-contained unit, all batteries and loud speaker unit enclosed in the cabinet. Ample volume is assured for dancing or entertainment.

In this set extreme simplicity of operation has been obtained, at the same time retaining the selectivity of tuning and long distance reception that has distinguished all Kennedy receiving sets. Only two dials are used—one to bring in the desired station, the other to regulate volume. Truly a set of which the Kennedy laboratories can justly be proud.

You can arrange with the nearest Kennedy dealer for a demonstration, or write us direct for descriptive literature.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS SAN FRANCISCO

THE KENNEDY MODEL X

This beautifully inlaid mahogany cabinet encases a complete, self contained radio receiver (wave length range 150 to 600 meters.) Two stages of audio amplification, built-in loud speaker. Formica panel. Dials and metal trimmings gold plated. All dry batteries—three dry battery tubes—phones for weaker signals or individual reception—complete, $285.00

All Kennedy radio receiving sets are regenerative—licensed under Armstrong U. S. patent No. 1,113,149

KENNEDY

The Royalty of Radio

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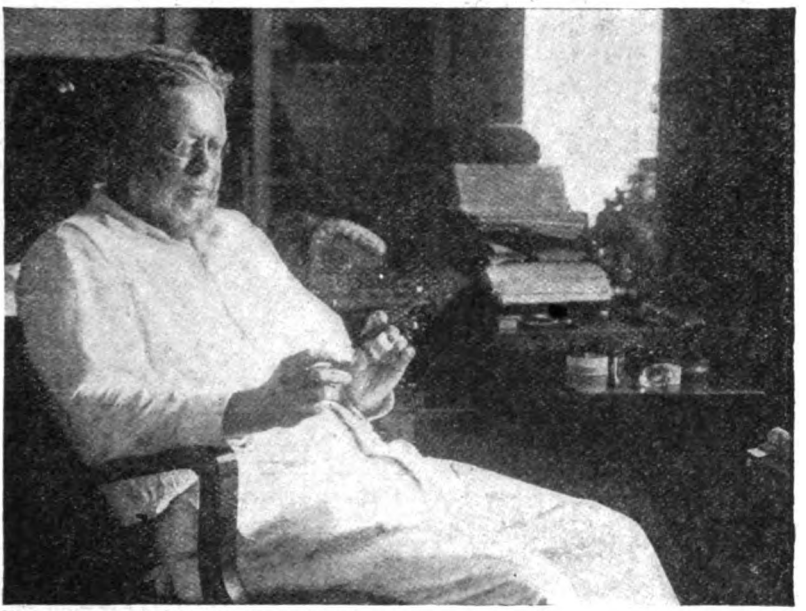

From a photograph made for POPULAR RADIO

"THE HEAVISIDE LAYER IS REAL"

So says Dr. Reginald A. Fessenden, the distinguished pioneer in radio, who contributes an important article on the much-discussed "sliding wave" theory in a coming issue of POPULAR RADIO.

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Western Electric

ENGLAND'S FOREMOST AUTHORITY ON THE ELECTRON

SIR JOSEPH J. THOMSON, *the discoverer of the electron and a foremost investigator of the structure of matter, whose observations on the elements of the electrons as expressed in the following pages are of value to both the scientist and the layman.*

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Popular Radio

VOLUME IV SEPTEMBER, 1923 NUMBER 3

NEW THEORIES OF

How the Atom Is Put Together

How atoms make up all kinds of matter—even the bodies of living men

THE idea of the electron has revolutionized modern physical science. All electricity is composed of electrons. When electrons accumulate at one particular place they cause what we call an electric charge; when they are in motion they constitute an electric current. The electric impulses which produce the waves of radio are merely surges of electrons, millions of billions of them, back and forth in the antenna wires. Electrons are also the building stones of matter itself. Atoms are composed of electrons arranged in space around a central nucleus which is positive in charge, the electrons being negative.

Sir Joseph J. Thomson, who discovered the electron back in 1897, has been studying recently the probable arrangement of these electrons inside the atoms of matter and the effects of this arrangement in determining the chemical properties of the different elements. The following article is based upon recent lectures on "The Electron in Chemistry" delivered by Sir Joseph before the Franklin Institute in Philadelphia, and is published by permission of the Institute.

—EDITOR

By SIR JOSEPH JOHN THOMSON, O.M., F.R.S., LL.D., Ph.D., D.Sc.

I BELIEVE that the introduction of the idea of the electron will break down, and indeed has already done so to some extent, the barrier of ignorance which has divided the study of the properties of matter into two distinct sciences, physics and chemistry.

The properties of matter which are of primary importance to the chemist are those which relate to the power of atoms to unite together to form new combinations, new compounds. Until recently the conception of the atom, formed by the physicist, afforded no clue to the variation in the chemical properties of the atom and gave therefore but little guidance to the chemist in what he rightly regarded as the most important part of his work.

The chemist wants to know much more about the difference between an atom of hydrogen, and one of oxygen than that "the atom of hydrogen is a small particle of one kind of matter" and that "the atom of oxygen is a heavier particle of another kind of matter."

The chemist wants to know the rea-

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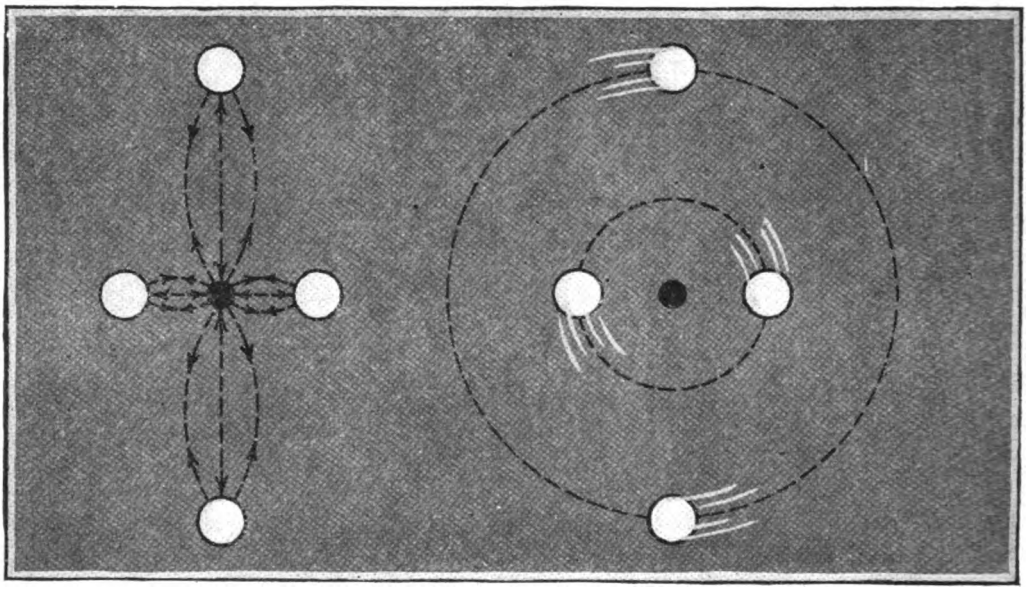

THE TWO PREVAILING THEORIES OF THE STRUCTURE OF ATOMS—

Illustrated by one of the simplest atoms, that of the element Beryllium. The figure on the left shows the theory of Sir Joseph J. Thomson, as embodied in this article. The four electrons, represented by white spheres, are held by a balance of attractive and repulsive forces at definite distances from the central nucleus of the atom, represented by the black dot. The other figure (at the right) shows the alternative planetary theory, according to which the electrons are supposed to be revolving around the nucleus much as the earth and the other planets revolve around the sun.

son why the behavior of an atom of hydrogen is so different from that of an atom of oxygen. This must depend upon the difference in the constitution of the two atoms themselves. Thus to explain the difference between the chemical properties as different atoms we have to go a step further than that considered by the atomic theory. Just as some of the physical properties of matter in bulk had required for their explanation the conception that matter is not continuous but has a structure of finite and measurable fineness, so no progress could be made towards the explanation of their chemical properties until we gave up the idea that the atom was indivisible, continuous and uniform, and assigned to atoms, as well as to solids and liquids, a structure of their own.

The discovery of the electron in 1897 was the first direct evidence of such a structure. It was shown that these electrons came from all types of atoms, and that whatever the source there was only one kind of electron, which has a mass of only about 1/1700th that of an atom of hydrogen and carries a charge of negative electricity numerically equal to the positive charge associated with an atom of hydrogen in the electrolysis of solutions.

Thus an invariable electron was proved to be a constituent of all atoms. Means were then devised to measure the number of electrons in the atoms of the different chemical elements. It was found that this number was finite and varied from element to element, and that the number of electrons in the atom of an element was equal to the atomic number of the element—the atomic number of an element being its place in the list when the elements are correctly arranged

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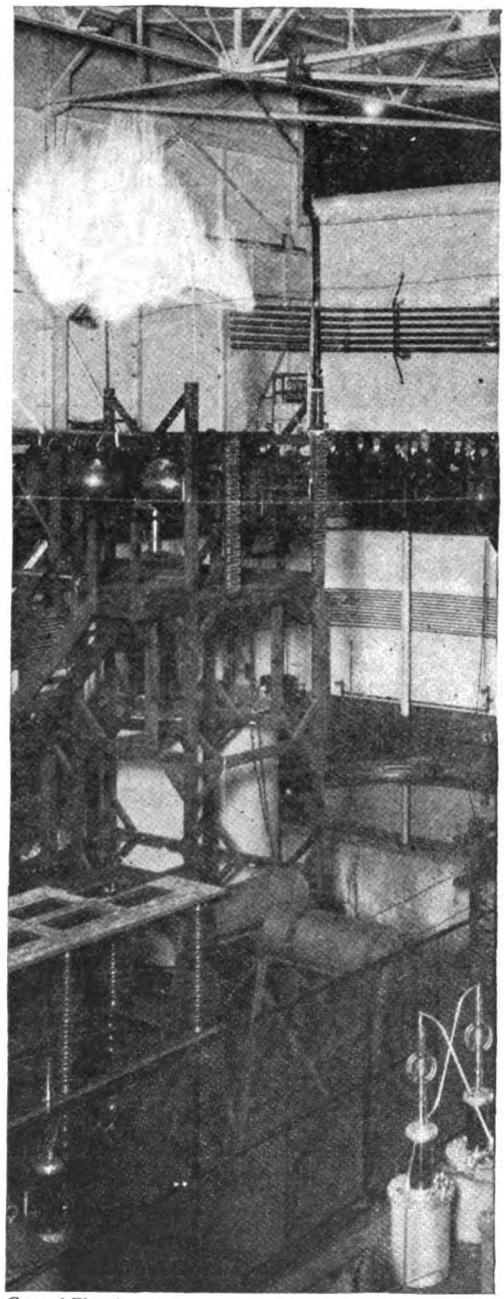
in the order of their atomic weights.

The electrons, however, only account for about 1/3400th of the whole mass of atoms, and for most purposes this is a negligible fraction. The greater part of the mass is accounted for by the positively electrified part of the atom. The electrons are all uniform and are negatively electrified, and as the normal atom is electrically neutral, there must be within it a positive charge to balance the negative one on the electrons. This positive charge, as experiments on positive rays show, is attached to a mass equal to the mass of the atom. Thus the carrier of the positive charge, unlike that of the negative, does vary from element to element. As the mass of the positive charge is always an integral multiple of a unit, it is natural to suppose that this mass is made up of a number of units bound together.

Thus, in addition to the structure conferred by the electrons, the positively electrified parts of the atom have themselves a structure. It is the structure conferred by the electrons which is responsible for the chemical properties of the atom, and the structure of the positive core or nucleus is concerned with radioactive transformations.

Up to the present time nothing has been discovered that cannot be resolved into electrons and positively electrified particles, and so it is natural to frame a theory of the structure of the atom on the supposition that it is built up of these two ingredients. It should be borne in mind, however, that our means for detecting the existence of electrically charged bodies far surpass those for detecting uncharged bodies, and if there were any uncharged constituents of the atoms, they would in any case probably have escaped detection. We know, however, even supposing that such constituents do exist, that their mass must be negligible compared with that of the positively charged parts, for these parts account



General Electric

A VIOLENT ELECTRON DISCHARGE

This "artificial lightning" is merely a rushing mass of electrons flying with incredible swiftness from one electrode of the spark gap to the other, knocking off electrons from the gas atoms which go to make up air and manifesting itself in a crashing bolt, which is second in destructive power only to nature's own lightning.

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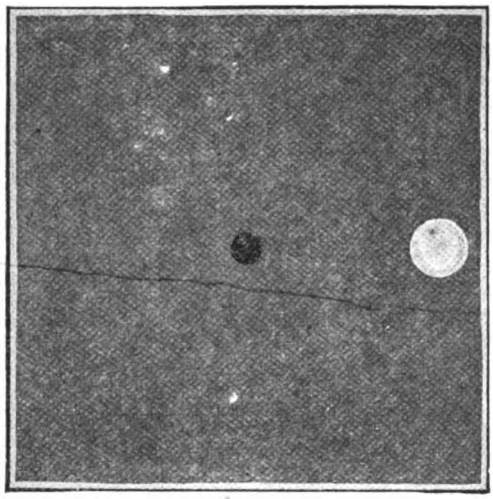
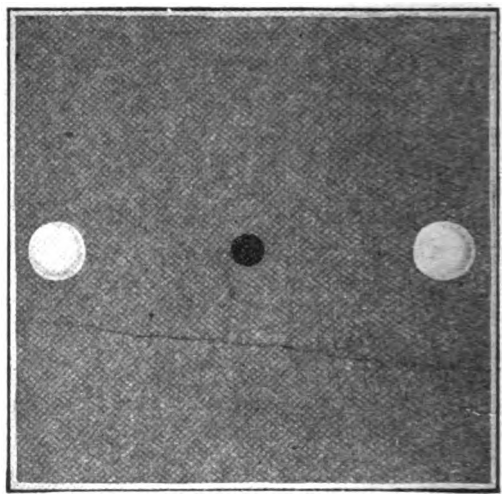


THE ATOM OF LITHIUM

3 **Model of the atom of lithium according to the Thomson theory. The two electrons closest to the nucleus, as shown on page 180, are omitted in this and following models for the sake of clearness. This lithium atom contains only the one electron shown in the shell outside these two inner electrons.*



THE ATOM OF BERYLLIUM

4 *Model of the atom of beryllium, the same atom shown on page 180. The two inner electrons that are there shown are omitted in this model just as they are omitted in the adjoining model of atom Number 3. The two external electrons are balanced one on each side of the nucleus.*

for well within a fraction of a per-cent of the whole mass of the atom.

Confining themselves, then, to the consideration of things the existence of which has been demonstrated, we regard the atom as made up of a massive positively electrified center surrounded by electrons; the number of electrons varying from one, in the atom of hydrogen, to a hundred or more in the heavier elements. The positive charge of the center and the negative charges on the electrons produce a field of electrical force which is determinable when the position of the electrons are specified.

Thus the force exerted by the atom, and therefore its chemical properties, depend upon the configuration of the electrons and to determine this is one of the most important problems in the electron theory of chemistry.

This problem is that of determining the way the electrons arrange themselves under the action of their mutual repulsions and under the effect of forces exerted by the positive charge.

I have adopted the plan of supposing that the law of force between the positive part and the electrons is, at the distances with which we have to deal in the atom, not strictly that of variation with the inverse square of the distance, but a more complex one which changes from attraction to repulsion as the distance between the positive charge and the electron diminishes. This hypothesis leads to a simple mental picture of the structure of the atom and its consequences.

In this connection it may be observed that the introduction of some new physical law is necessary for any theory of the structure of atoms. We could not form a theory at all if all we knew about the action of electric charges was that they repelled or attracted inversely as the square of the distance, for this would put at our disposal only two quantities—the mass of an electron and its charge, and so we could not furnish

*These numerals refer to the atoms in order of atomic number.

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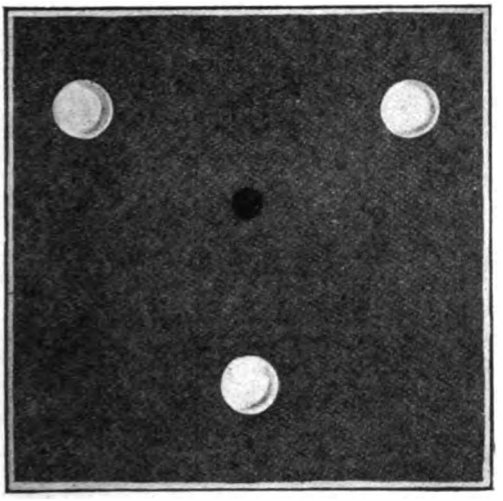

THE ATOM OF BOREON

5 *Like atoms number 3 and 4 the electrons of this atom (the atom of boron) are arranged in the same plane about the atomic nucleus at equal distances from it and from each other.*

the three units of *space, mass* and *time* required for any physical theory.

The discovery of the induction of currents or (what is equivalent) the magnetic effect due to electric charges, introduced another fundamental unit, the *velocity of light;* the unit of length to which this system leads is the radius of the electron, about 10^{-13} cm., a quantity of quite different order from 10^{-8} cm., which corresponds to atomic dimensions. The size of atoms being what it is furnishes proof that there is some law of physics that is not recognized in the older science.

If the law of force is that just given, then a number of electrons can be in stable equilibrium around a positive charge without necessarily describing orbits around it.

Thus, for example, if there is one electron in the second shell of the atom (ignoring the two inner electrons that are shown on page 180), this electron will be in stable equilibrium at a certain distance from the positive charge. If there are two electrons they will be in equilibrium with the positive charge midway between them. When there are three electrons, they will be in equilibrium at the corner of an equilateral triangle with the positive charge at the center. The most symmetrical arrangement of four electrons is when they are at the corners of a regular tetrahedron. Six electrons are in equilibrium when at the corners of a regular octahedron. Eight electrons arrange themselves at the corners of a twisted cube, a figure obtained by making two squares, placing them parallel to each other and at right angles to the line joining their centers, and twisting them relatively to each other so that the projection of their corners on a parallel plane forms a regular octagon.

There must come, however, a stage when it will no longer be possible to have all the electrons at the corners of a regular polyhedron.

To keep the electrons in stable equilibrium in spite of their mutual repulsion requires a finite positive charge and the greater the number of electrons (and, therefore, the smaller the angular distance between an electron and its nearest neighbor) the greater the positive charge must be. When the number of electrons is not greater than eight, the electrons can be kept in equilibrium by a positive charge equal to the sum of the negative charges on the electrons, which is the greatest positive charge which can occur in a neutral atom. So that when the number of electrons is not greater than eight, a neutral atom can have these electrons arranged symmetrically at the same distance from the center at the corners of a regular polyhedron.

When, however, the number exceeds eight this is no longer possible. To keep, say, nine electrons in stable equilibrium would require a positive charge of more than $9e$, where e is the charge of an electron, but in a neutral molecule $9e$ is the maximum positive charge available when there are nine electrons in the atom. Thus the regular pro-

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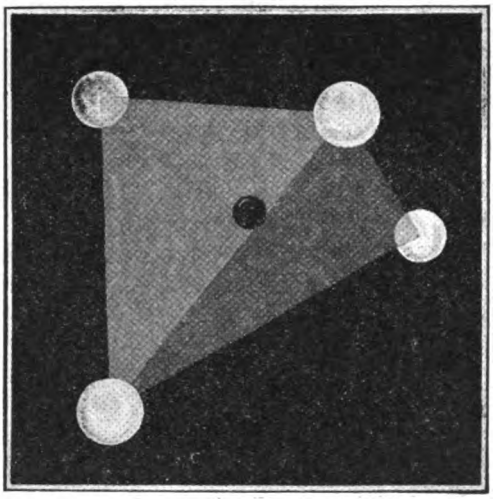
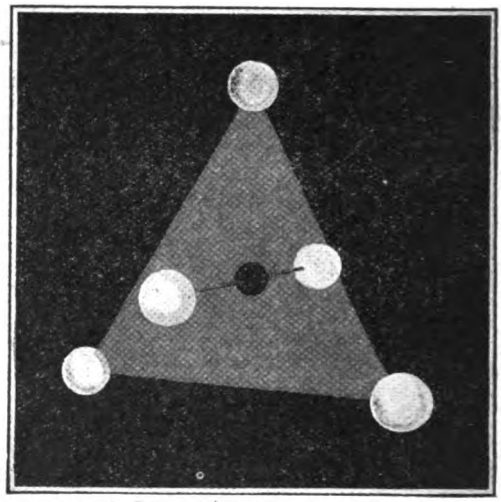


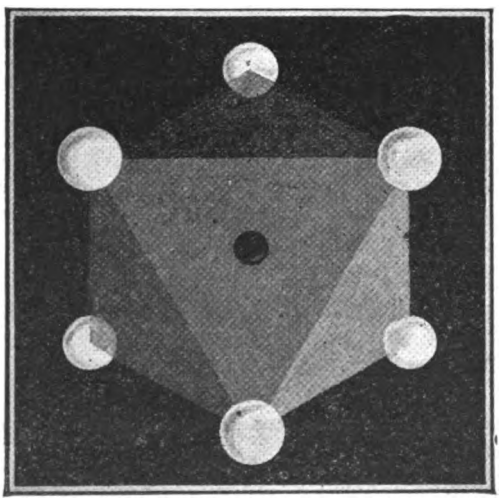
THE ATOM OF CARBON

6 *This is the atom of the very common element carbon, the element of coal and of diamonds. Its four external electrons are arranged about the nucleus at the corners of an imaginary tétrahedron. As before, the two internal electrons are not shown.*



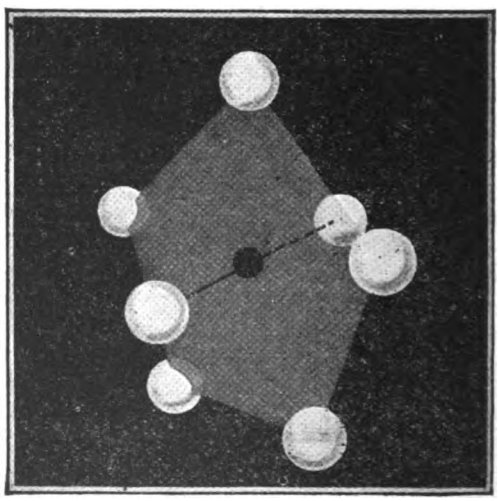
THE ATOM OF NITROGEN

7 *The atom of nitrogen—the gas that composes four-fifths of the air. In this there are five external electrons, three of them arranged at the corners of an imaginary triangle, the other two at the ends of a perpendicular line through the center of this triangle.*



THE ATOM OF OXYGEN

8 *One of the most important of all atoms, the atom of oxygen. This element is the commonest element in the earth's crust and is the element we breathe in air. Its six external electrons are arranged at the corners of an imaginary eight-sided solid or octahedron.*



THE ATOM OF FLUORINE

9 *The atom of fluorine, containing seven external electrons. Five of these electrons are arranged in one plane through the nucleus, as though at the corners of a regular pentagon; the other two electrons are at the ends of a perpendicular line, as in the case of atom number 7, shown above.*

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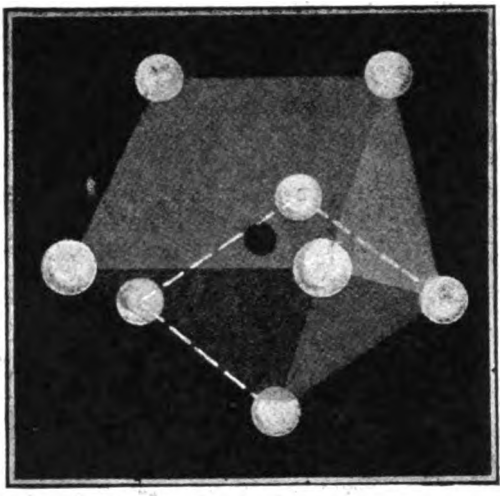
gression in the arrangement breaks down when the electrons amount to eight and a new arrangement must come into force.

Let us suppose that there are nine electrons; then these nine cannot all be arranged at the same distance from the center, for this arrangement would be unstable since a positive charge of nine is insufficient to keep nine electrons in stable equilibrium. The charge $9e$ could, however, keep eight electrons in stable equilibrium at the same distance from the center, leaving one to go outside, relatively a long way out from the center of the atom.

If there are ten electrons, these can be arranged so that eight form a layer round the center and two go outside. Eleven electrons can be arranged with an inner layer of eight and an outer one of three, and so on. Sixteen electrons can be arranged with an inner layer of eight and an outer layer of eight.

We have now got eight electrons on the outer layer and there is not accommodation for any more; as the atom is neutral, the excess of positive over negative electricity in the system consisting of the central charge and the inner layer is equal to the charge on the electrons in the outer layer. We can, however, get a system which will be in stable equilibrium if the electrons proceed to form a third shell; thus, if there are seventeen electrons, we could have an inner shell of eight, then another shell of eight and then an electron a long way outside. If we had eighteen electrons we should get two shells of eight and two electrons outside, and so on, until with twenty-four electrons we shall have filled up the third shell and have to begin again.

Thus, if we arrange the elements in the order of the number of electrons in the atom, which is the same as the order of the atomic weights, there will be a periodicity in the number of



THE ATOM OF NEON

10 *The atom of the rare gas neon. This contains eight external electrons, which is the greatest number of electrons, Sir Joseph Thomson believes, that can be held in a single shell all at the same distance from the nucleus.**

electrons in the outer layer. It will increase from one to eight, then drop again to one; increase again to eight, drop to one, and so on. Thus, as far as properties depending upon the outer layer are concerned, the elements will show a periodicity in their properties similar to that expressed by Mendeleef's periodic law in chemistry.

The valency of an element is a property depending on the number of electrons in the outer layer, the electropositive valency being proportional to that number, so that this type of atom would explain the periodic law.

There are some other interesting results which follow at once from the view we have taken of the constitution of the atom. One is the change in the chemical properties produced by electrifying the atom. Let us take the oxygen atom as an example, it has six electrons in the outer layer, and its

*With the preceding seven models this completes the list of the first ten elements. Element number one (hydrogen) and number two (helium) are not shown in this series as they contain only the two internal electrons shown on page 180; hydrogen having one electron only, helium having both of them.

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valency is determined by the number of electrons in this layer.

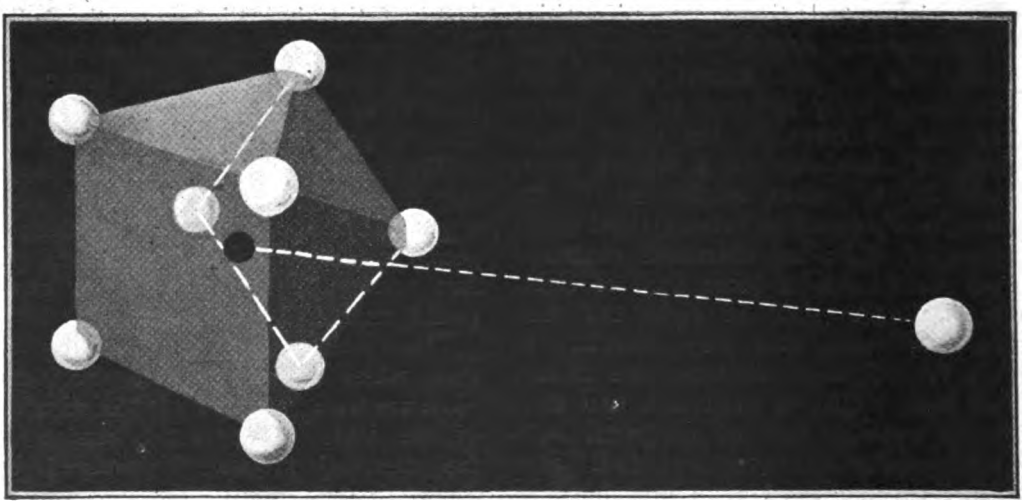
When the oxygen atom is positively electrified it has lost one or more electrons. If it is electrified so that it has lost one electron, the atom will only have five electrons in the outer layer, the same number as there are in a neutral atom of nitrogen. Thus, if the valency depends on the number of electrons in the outer layer, the valency of oxygen carrying a unit charge of electricity ought to be the same as that of a neutral atom of nitrogen, i. e., it ought to form the compound OH_3, a compound having the molecular weight 19.

This is confirmed by observation with the rays of positive electricity; when hydrogen and oxygen are present in the tube, a line corresponding to this molecular weight is frequently observed.

If we turn to negatively electrified atoms, a negative electrified chlorine atom would have eight electrons in the outer layer, it would resemble the neutral atom of an inert gas and so would not be able to enter into chemical combination. It might be expected to resemble argon not merely in its chemical properties, but also in the nature of its spectrum. Again, a positively electrified potassium atom has lost an electron and so would contain the same number of electrons as a negatively electrified chlorine atom or a neutral argon one. Thus we should expect the spectrum of positively electrified potassium atoms to show similarities with that of negatively electrified chlorine atoms and with neutral argon atoms.

Professor Zeeman and Mr. Dik have compared the red spectrum of argon, with the spectrum due to the positively electrified potassium atom and have found some exceedingly interesting points of resemblance.

Similarly, positively electrified oxygen atoms might be expected to give spectra resembling those of neutral nitrogen atoms and positively electrified nitrogen atoms might show similarities with neutral carbon atoms.



WHAT HAPPENS WHEN MORE THAN TEN ELECTRONS TRY TO CROWD INTO A SINGLE ATOM

11 *The eleventh electron goes into a second shell at a distance from the nucleus 6.7 times as great as the distance of the first shell of eight electrons shown in the preceding models. This eleven-electron atom is that of sodium, one of the elements in common salt. The remainder of the eighty-seven different chemical elements are formed by adding more electrons to this outer shell and then, in succession, to still other shells at still greater distances from the nucleus.*

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Underwood & Underwood

A CLASS OF APPLICANTS STUDYING THE CODE

You must be able to receive ten words a minute in order to qualify for the amateur first-grade license. This requirement is not difficult to obtain.

HOW TO GET A RADIO LICENSE

There are now about 19,000 amateur stations in the United States that are licensed to transmit. This article tells how to enter this Inner Circle

By H. M. DAVIS

GENERAL radio communication is carried on in what to most of us is a foreign language—a peculiar language, composed of dots and dashes. Study and practice is necessary before one can talk through the ether with it, although it is easy enough to listen in.

Because of the difficulty of mastering this code language and the necessity of keeping the ether free of inexperienced novices, a license is required before one is permitted to operate a transmitting apparatus. As thousands of radio fans have learned in the last few months, no license of any sort is required by the government for a receiving set in the United States.

Just as the immigrant who comes to this country reads the preamble to the Constitution to prove that he can command the English language sufficiently to make his way about, so there is a

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minimum speed requirement in the use of the Continental Morse code for passing the amateur's test. The operator must be able to send and receive ten words a minute, and has to understand the international abbreviations, two of which are "SOS," the signal of "distress" and "QRM" meaning "Interference."

But why is a license necessary for operating a radio telephone transmitter? The reason is sufficient.

Sending stations are apt to interfere with one another. The number of wavelength bands is so relatively small for the great amount of traffic that is already being sent over them—that considerable regulation is necessary in order to give an equal chance to all. Of course the control must be centralized in one place, or disputes would arise which would end in the hopeless deadlock of two small boys, one saying, "My mother says I can play in your yard," and the other, "My mother says you can't." In fact, it would be worse, for there would be no strong right arm to settle the matter. So Congress has provided the arm to start with, and power to regulate radio communication has been vested in the Secretary of Commerce, who administers it through the Commissioner of Navigation. The present law makes no difference between radio telegraph and radio telephone.

If you are an American citizen, it is not difficult to get a sending operator's license, provided, of course, that you know the Continental Morse code. The first step is to find out who the district Radio Inspector is and get in touch with him.

The United States is divided into nine radio districts; the area of each is based upon its population and need for radio supervision.

The First District comprises the New England States, and its Inspector is at the Customs House at Boston. The Second District has its headquarters at the Customs House at New York City and takes in the counties of New York State along the Hudson River, Long Island, and the northern part of New Jersey. The rest of New Jersey, southeastern Pennsylvania, Delaware, Maryland, the District of Columbia, and Virginia are included in the Third District. This Inspector's office is at the Customs House at Baltimore, and he has jurisdiction also, at present, over the Fourth District, which is composed of the southern Atlantic Coast States: North and South Carolina, Georgia and Florida; and the island of Porto Rico. In the near future, the Fourth District will have its own inspector, with headquarters at the Customs House at Savannah.

District Number Five takes in the southern states west of District Four, and extends as far north as the northern boundaries of Tennessee, Arkansas, Oklahoma, and New Mexico. Its Inspector is at the Customs House at New Orleans. The Sixth District takes in the southwestern corner of the United States: Utah, Arizona, Nevada, and California, and also extends itself to take in Hawaii. Its headquarters is at the Customs House at San Francisco. Seattle, Washington, is headquarters for the Seventh District, and its Inspector is to be addressed at 2301 L. C. Smith Building. This district comprises Wyoming, Montana, Idaho, Oregon, Washington, and Alaska. The Eighth District takes in the rest of New York not included in District Two, the rest of Pennsylvania not included in District Three, West Virginia, Ohio, and the lower peninsula of Michigan; its Inspector is at the Federal Building in Detroit. The Ninth District takes in all that is left; its northern boundary follows the Canadian border east from North Dakota through the middle of Lake Superior, then curls down through Lake Michigan to the northern boundary of Illinois. Its Inspector has his headquarters at the Federal Building in Chicago.

Having written to the Radio Inspector of the proper district, the prospective operator receives application blanks for his

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Form 163

PROVISIONAL
ORIGINAL

Official call 2 Z A *Number* 575

LICENSE FOR GENERAL (Grade of license granted) AMATEUR RADIO STATION

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

Pursuant to the act to regulate radio communication, approved August 13, 1912,

Donald J. Pierl, age 28, a citizen of the State of New York, county of Bronx, city or town New York, street East 175th Street, No. 154,

having applied therefor, is hereby granted by the Secretary of Commerce, for a period of two year s, on and subject to the restrictions and conditions hereinafter stated and revocable for cause by him, this License to use or operate the apparatus for radio communication identified in the Schedule hereinafter for the purpose of transmitting private radiograms or signals, notwithstanding the effect thereof extends beyond the jurisdiction of the State or Territory in which the said station is located: *Provided*, That no interference other than may result under the restrictions contained in this License shall be caused with the radio communication of stations of the Government of the United States or licensed stations.

2. The use or operation of apparatus for radio communication pursuant to this License shall be subject also to the articles and regulations established by the International Radiotelegraphic Convention, ratified by the Senate of the United States and caused to be made public by the President, and shall be subject also to such regulations as may be established from time to time by authority of subsequent acts and treaties of the United States.

3. The apparatus shall at all times while in use and operation be in charge of a person or persons licensed for that purpose by the Secretary of Commerce, and the operator of the apparatus shall not wilfully or maliciously interfere with any other radio communication.

4. The station shall give absolute priority to signals or radiograms relating to ships in distress; shall cease all sending on hearing a distress signal; and shall refrain from sending until all the signals and radiograms relating thereto are completed.

5. The station shall use the minimum amount of energy necessary to carry out any communication desired, and the transformer input shall not exceed one kilowatt.[1]

6. The station shall not use a transmitting wave length exceeding 200 meters.

7. The station shall not use a transmitter during the first 15 minutes of each hour, local standard time, whenever the Secretary of Commerce by notice in writing shall require it to observe a division of the time, pursuant to the Twelfth Regulation of the act of August 13, 1912.

8. The President of the United States in time of war or public peril or disaster is authorized by law to close the station and cause the removal therefrom of all radio apparatus, or may authorize the use or control of the station or apparatus by any department of the Government upon just compensation to the owners.

9. The Secretary of Commerce and Collectors of Customs or other officers of the Government authorized by him may at all reasonable times enter upon the station for the purpose of inspecting and may inspect any apparatus for radio communication of such station and the operation and operators of such apparatus.

10. The apparatus shall not be altered or modified in respect of any of the particulars mentioned in the following Schedule except with the approval of a radio inspector, or other duly authorized officer of the Government.

Name of naval or military station, if within 5 nautical miles, None

Power: ~~Transformer~~ Plate input, 80 W.[2] Antenna: Type (T, ⊓, etc.) Inverted L

Height, 60 (above ground); horizontal length, 80

Wires: Number in vertical part, 1; in horizontal part, 1

The normal sending and receiving wave length shall be 200 (Not exceeding 200) meters and the station is authorized to use the following additional wave lengths, not exceeding 200 meters: ~~_____~~ meters; ~~_____~~ meters.

This License expires on December 25th 1924

~~Eugene N. Swann~~,
Assistant Secretary of Commerce.

~~By Direction of the Secretary~~,
Commissioner of Navigation.

Delivered by Henry L. Roosevelt (Inspector)

Place New York, N. Y. Date December 26th 1922.

[1] Strike out "one" if the station is to be used only on board vessels of the naval or military forces, otherwise strike out "one half."
[2] Not to exceed 1,000, or if the station is to be used only on board vessels of the naval or military forces, not to exceed 500.

THE STATION LICENSE

This is the document that permits you to use your amateur transmitting station. It is issued to any American amateur who has already installed his transmitting antenna and planned his set and who can pass the tests that qualify him for the operator's license shown on page 193. This license is good for two years—providing you conform to the rules.

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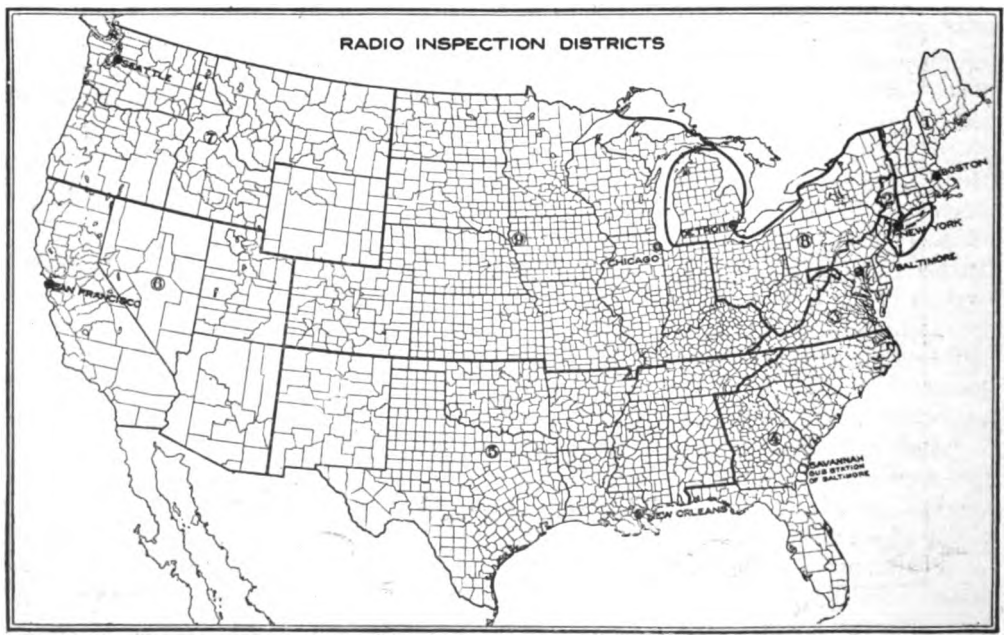
examination. Examinations are usually held at the offices of the district Radio Inspectors, but Inspectors may arrange examinations at other places in their districts when they deem it necessary.

The examination consists of two parts: A practical test on sending and receiving in the Morse Continental code, at which a speed of ten words a minute must be attained; and a written examination on the adjustment and operation of the prospective operator's apparatus and the regulations of the International Convention and Acts of Congress "in so far as they relate to interference with other radio communication and impose certain duties on all grades of operators."

The Radio Laws and Regulations of the United States, Part II, Section 121, states:

Amateurs, before applying for their operator's licenses, should read and understand the essential parts of the International Radiotelegraphic Convention in force and sections 3, 4, 5, and 7 of the Act of August 13, 1912. The Department recognizes that radio communication offers a wholesome form of instructive recreation for amateurs. At the same time its use for this purpose must observe strictly the rights of others to the uninterrupted use of apparatus for important public and commercial purposes. The Department will not knowingly issue a license to an amateur who does not recognize and will not obey this principle. To this end the intelligent reading of the International Convention and the Act of Congress is prescribed as the first step to be taken by amateurs. A copy of the radio laws and regulations may be procured for this purpose from the radio inspector or from the Commissioner of Navigation, Department of Commerce, Washington, D. C., but they are not for public distribution. Additional copies may be purchased from the Superintendent of Public Documents, Government Printing Office, Washington, D. C., at a nominal price.

If the applicant is so far away from the district headquarters that the expense of going there for examination would be too great, he may obtain a second-grade amateur operator's license without examination upon submitting evidence that he is qualified to hold a license. To do this, he gets an operator who holds a license to examine him on sending and receiving in code and upon the other



THE NINE "RADIO DISTRICTS" OF THIS COUNTRY

Each district has a Radio Inspector who is in charge of the radio experts who control the operation of all stations, issue licenses to operators and stations and who check up the wavelength of all transmitting stations within their districts.

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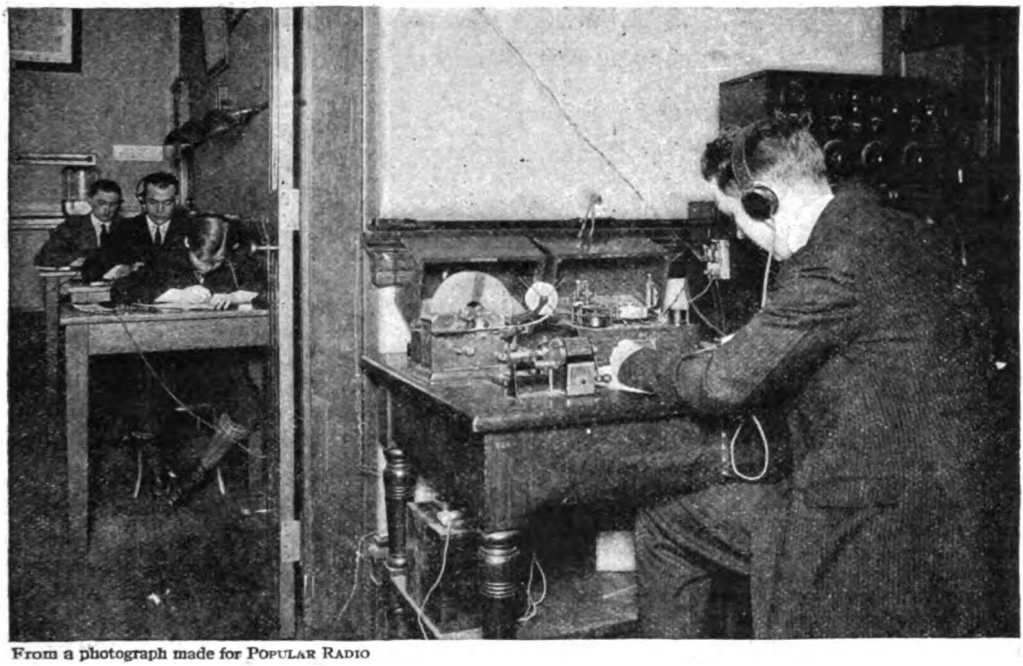

From a photograph made for POPULAR RADIO

HOW APPLICANTS FOR A TRANSMITTING LICENSE ARE EXAMINED BY THE RADIO INSPECTOR

A typical scene in the inspector's office. In this case assistant radio inspector Bogardus is sending "code" to applicants who are located in the next room with phones on their heads, copying down as much of the test messages as they can. The test papers are then corrected by the inspector and rated for speed in reception.

requirements, or he may go before a local radio club for such an examination. He sends in the statements of those who have examined him, and, if these are satisfactory, a second-grade license is granted him, subject to later inspection and examination by the Radio Inspector of his district. An amateur second-grade operator's license is usually granted for eight months. It may be revoked if the holder refuses to offer himself for examination when given opportunity to do so.

After receiving his operator's license, the applicant's sending apparatus is inspected and tested, and he is assigned his call and wavelengths. The call consists of a number followed by two, or more, letters. If the Inspector cannot go over his set at once, the amateur receives a temporary station license for use until his apparatus can be inspected.

Most amateur sending stations are classed as "general amateur stations," and their transformer input of power is 1 kilowatt or less. There are, however, "restricted amateur stations" whose input must not exceed one-half kilowatt. This restriction is placed upon stations located within five nautical miles of a naval or military station.

It is interesting to note that in all laws relating to radio supervision, distance is measured in nautical miles. The nautical mile is 6076.1 feet, or about 1⅛ land miles.

Each operator must have two licenses, the operator's license and the station license. These licenses are renewable at their time of expiration. Radio Laws and Regulations, Part III, Section 153 (b) says:

Operators holding licenses for grades other than commercial, who submit satisfactory evidence to the examining officer showing actual

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operation of radio apparatus for three months during the last six months of the license term, may be issued new licenses without examination. Otherwise, applicants for renewals will be examined in the usual manner.

No charge is made for any license or examination.

Having received his licenses, it is incumbent upon the operator to keep the rules and regulations which apply to his section of the ether. The first of these, which in these days of broadcasting seems a little bizarre, is secrecy. This is required, in fact, even of those who only listen.

No person or persons engaged in or having knowledge of the operation of any station or stations shall divulge or publish the contents of any messages transmitted or received by such station, except to the person or persons to whom the same may be directed, or their authorized agent, or to another station employed to forward such message to its destination, unless legally required to do so by the court of competent jurisdiction or other competent authority. Any person guilty of divulging or publishing any message, except as herein provided, shall, on conviction thereof, be punished by a fine of not more than two hundred and fifty dollars or imprisonment for a period of not exceeding three months, or both fine and imprisonment, in the discretion of the court.

But, of course, the rules and regulations were made originally for commercial operators.

Another rule strictly prohibits ship or coast stations from sending u necessary signals. This applies to amateur as well as commercial operators. Trials and practice are allowed only at times and under conditions that make interference with other stations negligible, and even then the experimenters are cautioned to listen in frequently for distress signals, which have right of way over everything else. Commercial operators not infrequently have their licenses withdrawn for sending unnecessary signals.

Transmission of profane language is forbidden by another rule.

Every licensed operator is assigned a wavelength upon which he must send, and he must be careful not to overstep his limits and interfere with other communication. Wilful or malicious interference constitutes a misdemeanor under the law, and is punishable by a fine of not to exceed five hundred dollars or imprisonment not to exceed one year, or both. It is often difficult for amateur operators to be sure that they are sending within their proper wavelengths, and the Bureau of Navigation has recently issued the following warning to them: "The Bureau has received a number of complaints recently of amateur stations using wavelengths in excess of those authorized in their licenses, which has resulted in much unnecessary interference. Amateurs should, if possible, have their wavelengths measured (*with a wavemeter*) to avoid violating the law."

In sending messages, the operator must give his call letter. This gives other operators a chance to take it up with him if his messages are interfering with those of other operators. Little trouble is experienced with operators sending without a license. There is a strong sentiment against such a practice among licensed amateur operators, who are very proud of their licenses, and they are quick to object when messages are sent out under irregular call letters. If such a rebuke does not silence the unofficial sender, and he becomes a pest, complaint may be made to the radio inspector of the district. If a reprimand from the district Inspector is not sufficient, the might of the law may be invoked against him, and the case turned over to the District Attorney. But trouble of this kind is rare. The American boy is a law-abiding citizen.

The inspecting force of the Bureau of Navigation for regulation of amateur operators is fast becoming inadequate. The district inspectors' offices being at the seaboard leaves the great interior of the country almost without supervision. The work of inspecting outgoing vessels to see that their radio outfits are in perfect working order is by far the most important duty of the Bureau of Navigation. Vessels upon the high seas are dependent upon their radio sets for all their com-

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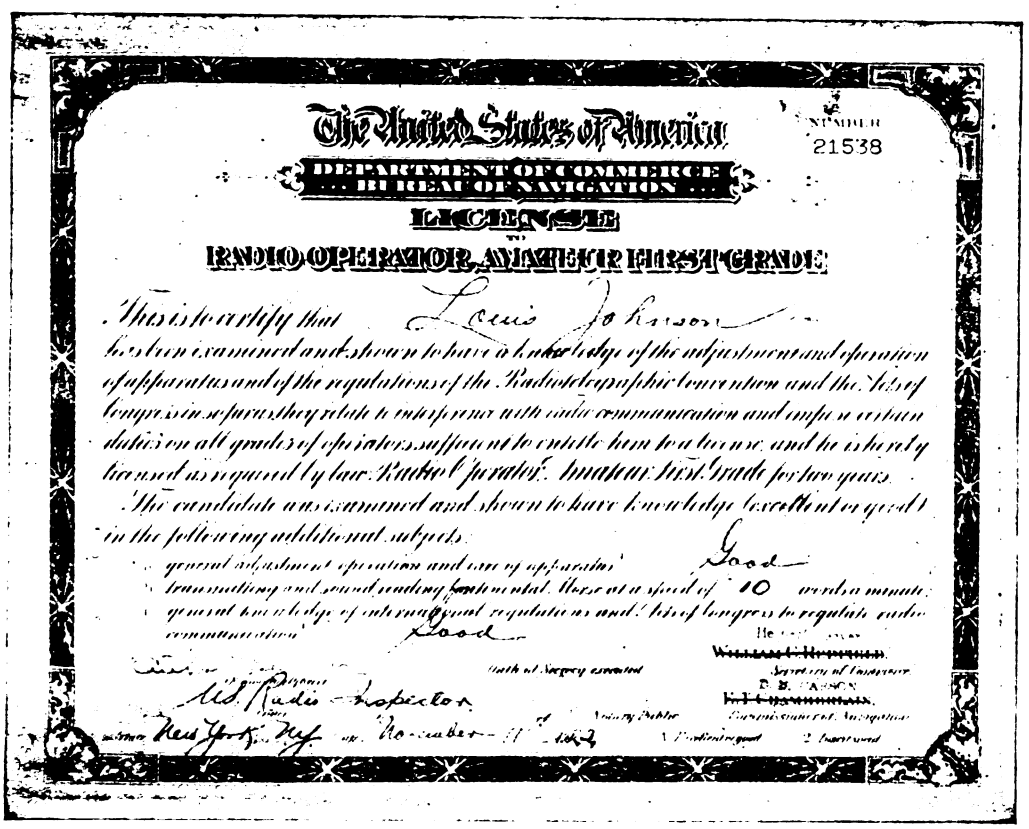

The United States of America

NUMBER 21538

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION

LICENSE

TO

RADIO OPERATOR, AMATEUR FIRST GRADE

This is to certify that Louis Johnson

has been examined and shown to have a knowledge of the adjustment and operation of apparatus and of the regulations of the Radiotelegraphic convention and the Act of Congress insofar as they relate to interference with radio communication and imposes certain duties on all grades of operators sufficient to entitle him to a license, and he is hereby licensed as required by law. Radio Operator, Amateur First Grade for two years.

The candidate was examined and shown to have knowledge (excellent or good) in the following additional subjects:

(1) general adjustment operation and care of apparatus Good

(2) transmitting and sound reading instrumental. Horse at a speed of 20 words a minute

(3) general knowledge of international regulations and Acts of Congress to regulate radio communication Good

He [illegible]

Witness my hand this [illegible] day of [illegible] 1922

Oath of Secrecy executed

Secretary of Commerce

D. W. JAYNE

Chief Radio Inspector

Commissioner of Navigation

Witness my hand and official seal this 1st day of November 1922

Notary Public

My Commission expires [illegible]

1 Fingerprinted 2 Interviewed

THE AMATEUR OPERATOR'S LICENSE

This is the coveted document that is issued to you after you have passed the required examination. It is good for two years and is issued without fee other than the trifling cost of the notary's seal.

munication with the rest of the world, and in time of danger it is vital that radio messages can be sent. It is for this reason that inspectors' headquarters must be at the principal harbors of this country.

But since July 1, 1922, when a slightly larger appropriation was made available to the Bureau of Navigation for radio inspection, extension of the service of the district radio inspectors has been increased, and provision has been made to cover fully every large city in the United States. It is, of course, impossible for the Government to place inspectors in every county and every town at the present time.

For purposes of local regulation, the Amateur Committee of the Washington Radio Conference recommended that the office of Amateur Deputy Radio Inspector be created and conferred upon an amateur elected by the other amateurs of each locality. The person so chosen would serve without compensation, but would be clothed with whatever authority might be necessary to enforce the observation of such local co-operative measures as are agreed to in each community for the minimization of interference between the various groups of the public interested in radio. In case it were found that such officers could not legally serve without compensation, a nominal sum would be paid them. They would probably be "dollar-a-year" boys.

This plan is well thought of by the Bureau of Navigation, but whether it will be put into effect or not has not been de-

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International

HOW THE RADIO INSPECTOR CHECKS UP THE TRANSMISSION WORK OF THE AMATEUR

The "traffic cop of the ether" sits and listens in with his receiving apparatus, carefully checking up the wavelength of the transmitting stations in his district and keeping strict watch on the amateur so that messages may be handled with dispatch and without undue interference.

cided. It will not be necessary for the present, as the funds now available provide for an adequate inspection staff. Some plan of policing will ultimately have to be adopted, as there are close to a million receiving sets in the country, and the number of sending operators is increasing all the time.

Eight grades of licenses are issued by the Bureau of Navigation: (1) Commercial extra first grade; (2) commercial first grade; (3) commercial second grade; (4) commercial cargo grade; (5) commercial temporary permit; (6) experiment and instruction grade; (7) amateur first grade; (8) amateur second grade.

The commercial extra first grade is the highest license granted radio operators by the Government. It is issued to operators whose trustworthiness and efficient service entitle them to extra confidence and recognition. It may be earned by commercial first-grade operators who have put in eighteen months' satisfactory service on sea or land during the two preceding years and have not been penalized for violation of the radio laws and regulations, upon passing a special examination. In the examination a speed of at least 30 words a minute, Continental Morse, and 25 words a minute, American Morse, must be attained. The technical questions and the questions on the radio laws and regulations will be considerably wider in scope than those for commercial first grade, and a higher percentage is required, 80 or better on

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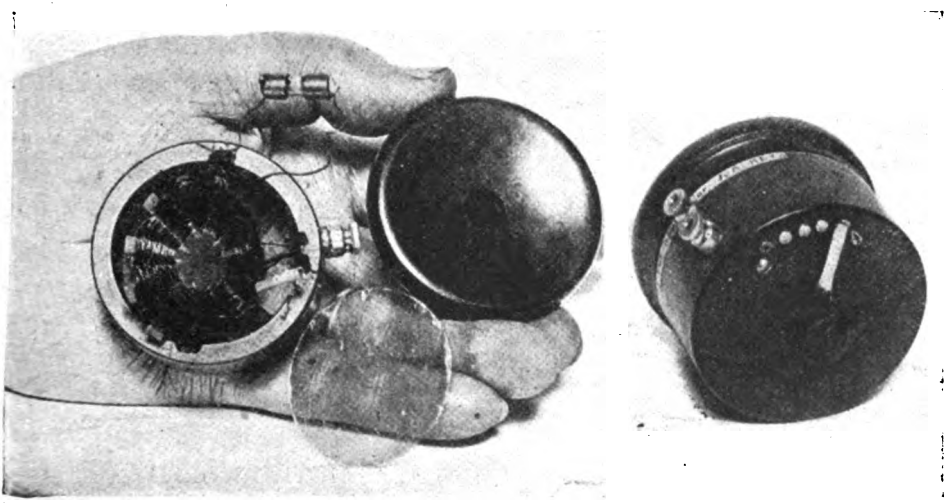
a score of 100.

The commercial first-grade applicant must know how to adjust, operate and care for his apparatus, correct its faults, and change from one wavelength to another. He is required to transmit and receive by ear at a speed of not less than 20 words a minute in Continental Morse. For these tests a word is agreed to consist of five letters. He must also know how to care for a storage battery and other auxiliary power apparatus, and he will be examined upon his knowledge of international regulations of radio communication and the requirements of the acts of Congress to regulate radio communication. An operator who holds a commercial first-grade license or a commercial extra first-grade license is qualified for employment at any ship or land station.

The commercial second-grade examination covers the subjects given for the first grade, but the questions asked are not as comprehensive in character. To operate in this class, a speed of only twelve words per minute is required.

All American steamers carrying radio outfits must keep a continuous watch for distress signals. On cargo vessels, one first or second-grade operator is required, but the man to relieve him may be any member of the crew or other person qualified to recognize the distress signal when it is included with other words and to recognize the call signal of his own ship. He must also be able to test the apparatus with a buzzer to determine whether it is properly adjusted to receive signals.

All the foregoing are licenses granted to commercial radio operators. There is another license which, while classed as a "commercial grade," may be issued to amateurs. It is known as the Experiment and Instruction grade. It has, however, no reference to the instruction of radio operators as such, but is required by those who operate stations carrying on scientific experiments but are unable to obtain commercial operators' licenses. To obtain this license the operator need know only the essential parts of the radio laws and regulations and be able to recognize distress and "keep out" signals, but he has to satisfy the radio inspector that his scientific attainments warrant his receiving a license of this class.



Kradel & Herbert

A RADIO RECEIVER THE SIZE OF A WATCH

This tiny tuner is properly enough the work of a St. Louis jeweler, Mr. J. A. Key. It contains a spider web coil with five taps. Binding posts connect to the antenna and ground wires.

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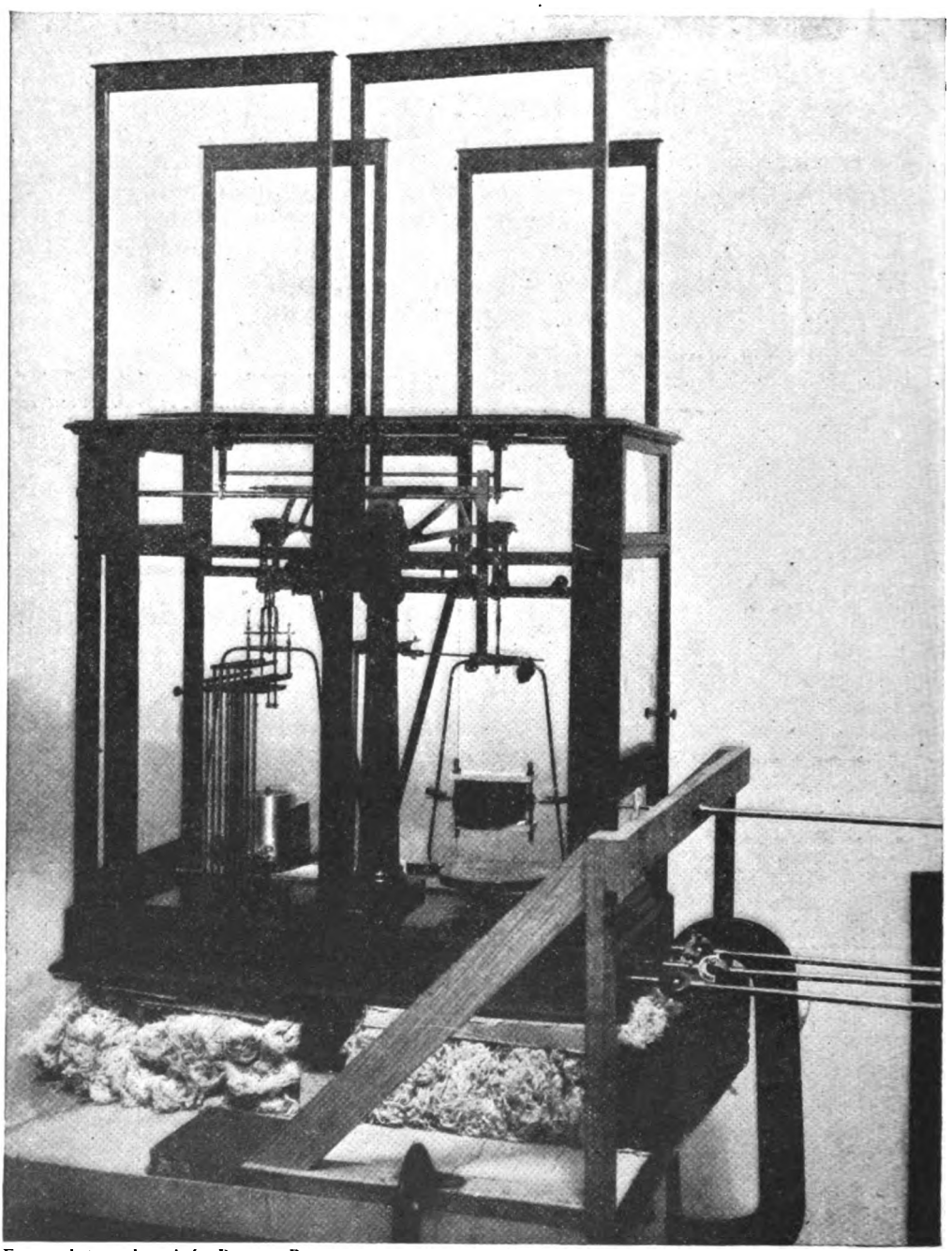

From a photograph made for POPULAR RADIO

THE MOST SENSITIVE SCALES IN THE WORLD

Here is shown the apparatus that weighs the crystal with an accuracy of at least one-thousandth of a milligram. The weighing instrument is so delicate that the body of a person in the balance room would change the temperature of the metal parts and thus introduce an error that would be ruinous.

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Testing the Einstein Theory with a Topaz

Is there an "ether push"? Is there indeed an ether?* These are questions that the scientists of the Bureau of Standards at Washington are trying to solve in their own way by an extremely delicate method for weighing a topaz crystal in different positions, in order to determine whether or not there is an actual ether "drift."

By ERNEST S. CLOWES

THE latest attempt to test the Einstein theory and to detect the ether experimentally is now in progress in the laboratories of the Bureau of Standards in Washington. It makes use of some very large single crystals, notably of the largest gem topaz ever found, a stone which happens to be in the collections of the National Museum.

The experiment consists in weighing this topaz in different positions on one of the most delicate balances ever constructed, and with an accuracy never before attained.

The experiment is really a test of gravitation. Dr. Paul R. Heyl, who is conducting it, is trying to find out whether the topaz crystal always weighs exactly the same in whatever position it may be placed, or whether it weighs a little more when it is right-side up than it does when it is laid on its side. If it turns out that the crystal always weighs exactly the same, it will be a big argument for the Einstein theory. If the crystal changes ever so little in its weight the Einstein theory will require modification.

The weighing is, of course, merely a device to detect any change in the force of gravitation between the earth and the crystal. All the theories of gravitation, from Newton down to Einstein, have pictured gravitation as some kind of a push or pull in the ether, like, for instance, a bombardment of the atoms of matter by particles of the ether.

Einstein, on the other hand, says that no ether of this kind really exists. There can be no pushes or pulls on matter by it. Gravitation, according to him, is a property of space, a kind of warp or kink in the ultimate substance of the universe which merely *seems* to us to be a push or a pull.

Now if the ether theory is right the push of the ether on the topaz crystal ought to be, Dr. Heyl thinks, different depending upon the position of the crystal. In substances that are not crystals all the atoms inside them are arranged every which way, like loose nails in a keg. But in crystals all the atoms have a regular arrangement, as though all the nails in a keg were carefully packed with their points all in one direction.

Any push of the ether, therefore, on the atoms inside the topaz crystal ought to have one value when the crystal is turned so that its atoms are pointed, so to speak, toward the ether push, and a slightly different value when it is turned in a different direction so that the push comes against what we might call the sides of the atoms. If there is any such difference it would show up as a difference in weight—and that is

*Charles P. Steinmetz, "There Are No Ether Waves," in POPULAR RADIO for July, 1922. Sir Oliver Lodge, "Are There No Ether Waves?," in POPULAR RADIO for November, 1922. E. E. Free, "Radio and Relativity," in POPULAR RADIO for April, 1923.

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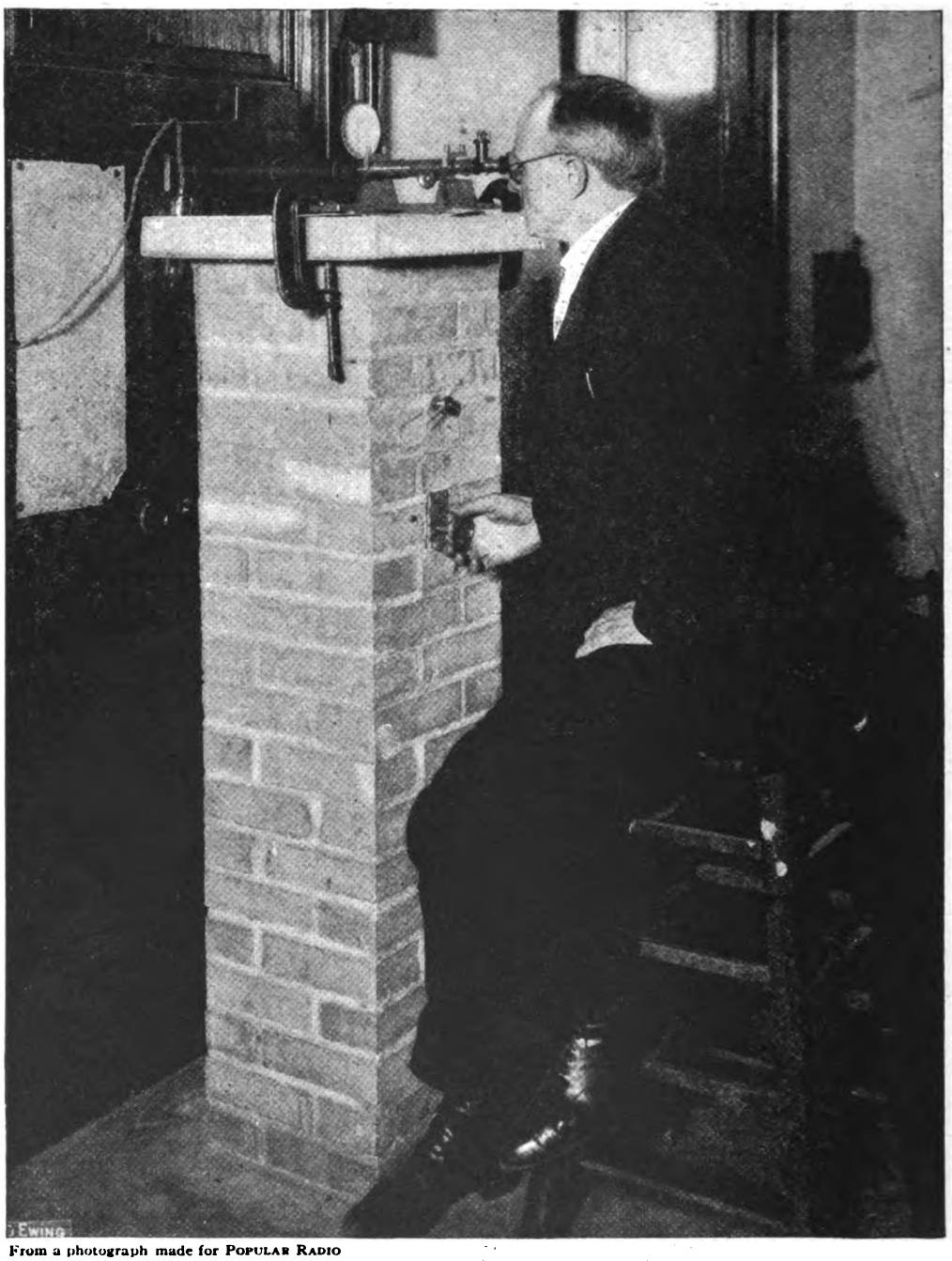

From a photograph made for POPULAR RADIO

DOES AN OBJECT WEIGH EXACTLY THE SAME IN ALL POSITIONS?

That is the question that Dr. Paul R. Heyl is attempting to answer. The actual weighing is done by means of control rods which run through the wall of the weighing chamber and terminate in a stone column upon which is located the recording apparatus. This precaution assures the constant temperature necessary for so delicate a balance.

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what Dr. Heyl is endeavoring to detect.

He first weighs the great topaz crystal in one direction. Then he turns it around through a right angle and weighs it again. The weighings must be correct to one part in a billion and the crystal to be weighed must be of considerable size, hence the use of the great topaz and the world-beating accuracy of Dr. Heyl's experiments.

The stone actually weighs a little more than three pounds. It is a white topaz, without the familiar yellow color of the ordinary gem, and it measures about five by four inches. It has been weighed to within about a thousandth of a milligram, or much less than the weight of a hair.

The balance used is of the ordinary chemical type for refined weighing of substances up to about five pounds. The unusual part is the extraordinary care that Dr. Heyl takes in using it. To begin with, the balance is, like all chemical balances, in a glass case. This case stands in the middle of a brick-walled, unheated cellar room about ten feet square, with double doors, no ventilation, and during the weighing, no lights. The final weighing is done by the experimenter who sits outside the brick wall and controls the balance by means of rods extending through it, watching the swings of the balance arm by the motion of a minute beam of light reflected from a tiny mirror on the arm.

That is for the completion of the weighing. The early stages are carried out in the usual way with the experimenter in the weighing room. When weights have been adjusted to the crude accuracy of about one part in a million or less, the experimenter prepares for the final touch. The entire balance case is surrounded by movable walls of a cork composition about two inches thick, leaving just room for the control rods and the small beam of light to come through. This is to protect the balance from any change of temperature during the weighing.

The operator then puts out the light, leaves the room, shuts the double doors, and leaves the whole affair alone for an hour or more. This is to enable the balance to come to constant and uniform temperature—a most essential feature of the experiment, for a difference in temperature between the two arms of the balance of something like a thousandth of a degree would introduce a ruinous error of something like one part in a hundred million. After everything has come to a uniform temperature the final weighing is made.

So far the experiments have confirmed the Einstein theory. The topaz, which is the only gem stone yet weighed, weighs exactly the same no matter what its position on the scale pan of the balance. It fails, therefore, as all the other tests have failed up to the present, to detect any experimental evidence of pushes or pulls due to the ether.

Does this settle the matter for good? Dr. Heyl thinks not. The big topaz says that Einstein is right, that the ether cannot be detected. But there are at least four other different crystal forms, having different atomic structures, which Dr. Heyl wants to test in the same way before he calls it a decision. These other crystals will be tested at once.

"Einstein has won the first round," says Dr. Heyl, "but there are four more rounds to be fought out. Final decision will be announced before fall."

A European Scientist's Conception of Ether

Few problems have so seriously engaged the scientists of the world as "the ether hypothesis," indeed, the conceptions of ether and ether waves have furnished the most plausible and easy-to-understand explanation of radio phenomena. In the next issue of POPULAR RADIO *will appear an article on this live subject by one of the most distinguished physicists of Europe—Prof. Emil Wiechert of the University of Goettingen.*

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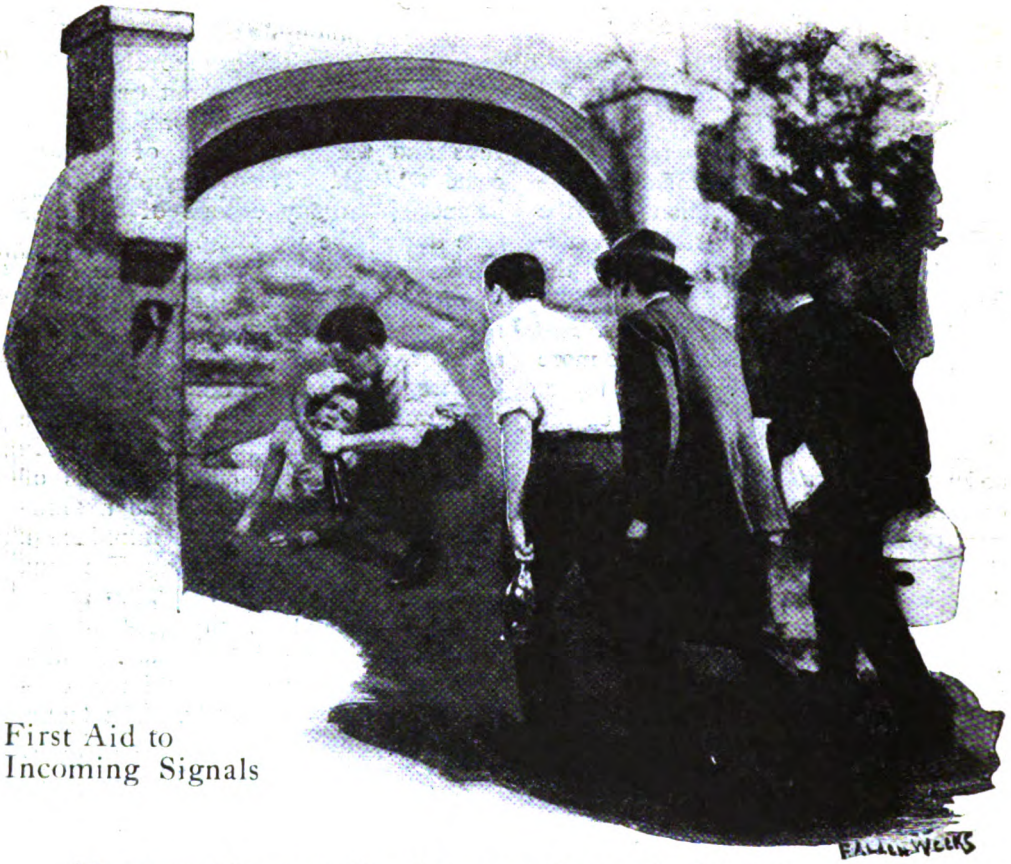

The vacuum tube may be likened to a town, the gate of which is the grid. A regenerative circuit buoys up and strengthens the weak signals that arrive in much the same way that the townsfolk would revive and resuscitate a runner who enters the gates of their town. This is accomplished in a vacuum tube circuit by sending out a helping current to meet and boost up the weak incoming impulses.

How the Vacuum Tube Works

ARTICLE No. 2: HOW WEAK SIGNALS ARE REGENERATED

This series of articles is designed to explain, in non-technical language that the layman can understand, some of the basic principles of radio phenomena

By ALFRED M. CADDELL

ALMOST everyone has heard of the great Marathon runner who, after hurrying twenty-six miles with a message, fell exhausted on the outskirts of town, barely able to whisper the words of his message. Indeed, it took a very sensitive ear to catch them; then they were repeated one to another until all the people in the town had heard the news.

It was an all-important message. If the town folk had known he was coming, they would have dispatched someone with a stimulant to assist him, help him bring the message into town.

In a way, the voice-controlled radio

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frequency wave is like a runner coming from afar, weak, but still able to convey a message. And just as he crosses the borderline of a town (the electron tube) he is met and carried on the shoulders of friends (electrons) who pick up his message and straighten it out (rectification) and strengthen it (amplification).

De Forest's introduction of the third electrode (grid) into the electron tube through which the "runner" enters, did not, of course, mark the birth of radio, but it certainly signalized the day radio attained its majority—its twenty-first birthday, so to speak. And if the triode or tube assumed importance on the introduction of the grid, that importance became greatly augmented the day the tube got married—the day it became properly hooked up with the local battery circuit so that a maximum output (regeneration) would result from the strength of the local battery circuit. As good an amplifier of weak radio frequency impulses as the triode proved to be, its value became greatly enhanced when the impulses became strengthened by feeding back part of the plate circuit energy into the grid circuit while the impulses are entering the tube.

"When an oscillation is induced in an antenna by a passing wave," says a radio engineer, "the current in the plate or local battery circuit would have a radio frequency variation as well as the audio frequency variation that causes the telephone receivers to function. In other words there are present in this circuit a radio frequency current and an audio frequency current superimposed on the direct current.

"In the ordinary audion circuit with which we are all familiar no use is made of this radio frequency plate current, but in the regenerative circuit on page 202 the radio frequency plate current flows through the tickler coil and so induces a radio frequency voltage in the secondary coil coupled with it. If these coils have the correct relative polarity, the voltage induced in the secondary will reinforce the radio oscillation in the grid circuit. This is, in turn, amplified by the tube, thus further increasing the plate current, and increasing the audio frequency current through the telephones. Hence the regenerative effect of the tickler coil is cumulative. By careful adjustment with the secondary, the oscillation may be built up to be much stronger than it would be without regeneration; and therefore the response in the phones is increased accordingly."

So much for the technical explanation.

While trying to learn the secrets of the vacuum tube, Edwin H. Armstrong reasoned that if the local battery circuit, instead of confining its energy to the tube only, could extend its influence into the input circuit, something of a progressive nature might happen. He found that by tapping the local battery current by means of a tickler coil and introducing this strength into the grid circuit during the time the radio frequency oscillations were going through the tube, that they became greatly strengthened and that the output of the tube was greatly increased. He also found that the output of the tube could be fed back into the original grid circuit by means of coupling transformers, through the tube again, again, and again, the oscillations becoming each time stronger and stronger.

Strange as it may seem, the "message," after going through the tube, may be led back through a circuit to go through the tube once, twice or three times, each time coming out stronger than before; and all in the twinkling of an eye!

Let us train our eyes again on the runner coming weakly into town (the tube), bearing an all-important message.

The helpers of this town establish circuit outposts (tickler coil) a little distance away from the town to ginger up the runner with a stimulant, so that he may bound into town fresher than he would have, and be helped immensely by the local organization there, with the re-

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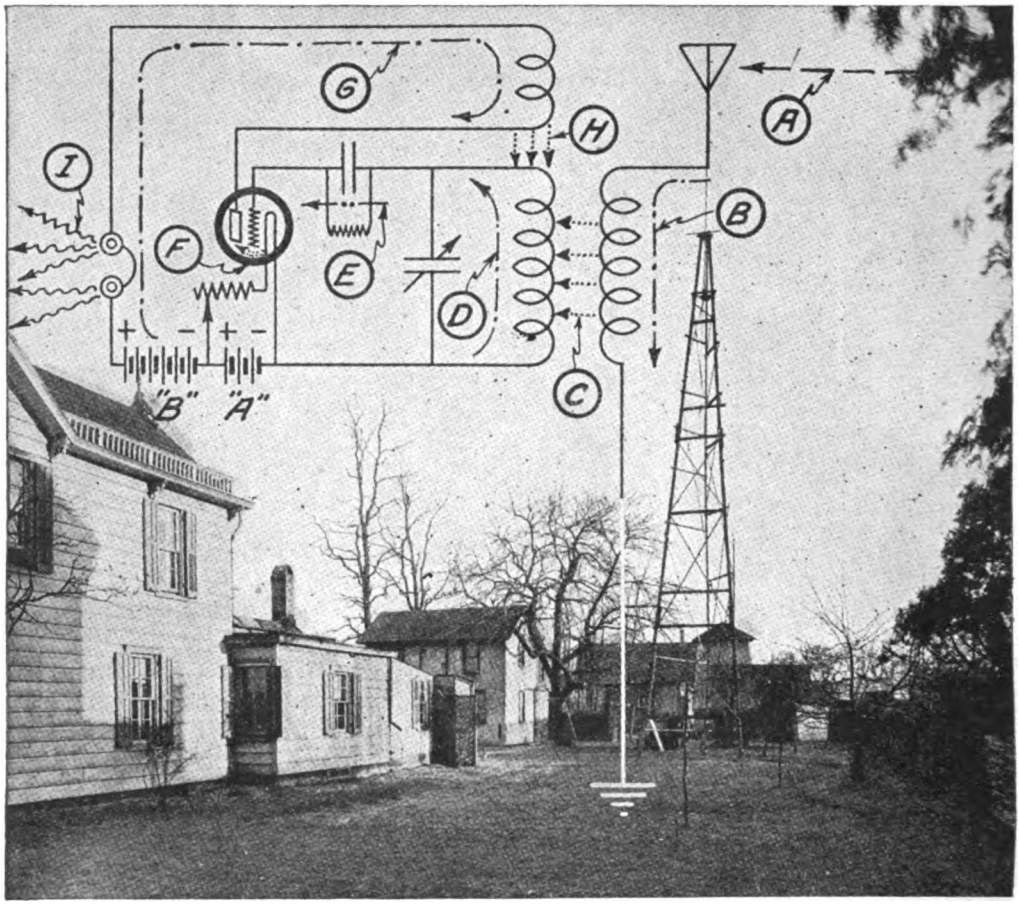

From a photograph made for POPULAR RADIO

HOW THE REGENERATIVE CIRCUIT OPERATES

The passing radio wave A, strikes the antenna and induces in it a feeble high-frequency oscillation or current B. This flow of current through the primary coil causes a magnetic transfer of energy C, to induce a similar current D, to flow in the secondary coil, and thus supplies the grid of the tube with a voltage impulse E. When the grid is charged with E, it causes a flow of electrons F, from the filament to the plate which results in a current G, which flows through the plate or feedback coil. From the plate coil there is a second magnetic transfer of energy H, to the secondary coil which results in a greatly strengthened current D, a greater voltage E, and therefore a much greater electron stream F and an amplified plate current G. In this way the circuit feeds the weak incoming energy through the tube a number of times until it is strengthened sufficiently to make powerful sound waves I, issue from the receivers.

sult that he, or the chorus representing him (amplification), would then be in a position to leave that town (tube) very much stronger.

The greater the variations in the oscillations introduced through the grid, the greater the variations in the local battery current, and consequently the louder the signals that may be obtained through the phones. Obviously, however, there is a limit to the number of times a "runner" may enter and re-enter the town; he cannot be shunted about too much, else he may get dizzy and commence to "oscillate."

Just so in radio receiving; too much regeneration or "feeding back" and a dizzy confusion or howling will be the

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result—the tube becomes a first-class oscillator. But just lately a method has been devised whereby a "runner" may be spun round and round the circuit many times without losing his balance. The radio frequency impulses are controlled in such a way that extreme amplification becomes possible, and oscillations that would otherwise happen are effectively choked off. A super-runner has arrived, so to speak—one capable of handling very short wavelengths—"super-regeneration."

Armstrong has lately evolved this method (super-regeneration) whereby, by an automatic action allowing the building up of a current to a very high amplitude for an instant followed by a short period of damping to prevent oscillation, an enormous amount of amplification is obtained. This action might be likened to the action of a quick interchangeable switch, feeding alternately and synchronously a negative and positive resistance into the grid circuit.

Thus the "runner," or radio frequency message, becomes strengthened without upsetting his balance (without causing him to become dizzy and confused) amplified to a degree of a million times or more. This is a development permitting the use of extremely short wavelengths and almost unlimited amplification.

But amplification in itself is a very wonderful story—how the original feeble impulse, or signal, after being rectified and regenerated in the first tube may be led on through succeeding stages of amplification, transformed, strengthened and passed on again and again, until—all of which we shall later picturize.

Kadel & Herbert

THE POWER BEHIND THE RADIO VOICE OF THE LEVIATHAN

Here is chief operator Pickerell examining the bearings of the large motor-generator which furnishes current for the high-powered C.W. and radio telephone transmitter on Uncle Sam's great liner. This is the largest and most complete vacuum tube installation that has been installed on any commercial vessel.

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ADVANCE AGENTS OF CIVILIZATION

When the officials of station PWX of Havana transported their receiving apparatus into the wilds of Cuba for the purpose of testing reception, they introduced radio to the natives—to whom the wonders of a new world are now being opened.

RADIO—*the* PACIFIST

Wars are based upon disagreements; disagreements are based upon misunderstandings—misunderstandings of motives, of temperament, of problems. Radio, which recognizes no geographical boundaries, is already beginning to bring the peoples of the world into closer contact in business, in culture, in social life; it is destined to be perhaps the most powerful factor for peace that the world has ever known. This article tells why and how.

By MAJOR-GENERAL JAMES G. HARBORD

THE other night I heard an official of the American Relief Administration tell over the radio of the fearful conditions that he and his co-workers had encountered in Russia; of communities cut off from the rest of the world and nearly depopulated by starvation; of "civilized" people who had reverted to cannibalism; of the unhindered sweep of preventable disease.

I sat in the comfort of a modern home and the latest marvel of science brought to my ears the best music and art and human thought. I had but to push a button and there came to me the words of men like these who are shaping the course of history. At my service were all of the comforts and conveniences of modern civilization. Yet measured in terms of the swift flight of the message I heard, less than a quarter of a second from my easy-chair were

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millions upon millions of human beings who have never heard of radio and who do not know the meaning of science or modern civilization!

They may have not progressed from the condition of their ancestors, thirty centuries ago. How swift has been the march of scientific discovery, and how tardy, in comparison, the development of mankind!

Here, it seems to me is disclosed the big job of radio—to be the messenger of a new age to the countless millions of human beings who are still living in the dark ages.

I do not mean that we must make our radio broadcasting stations heard in Russia or China and then provide the inhabitants of those countries with receiving sets. The problem is a more practical one than that, and we are well on the way to its solution. America is rapidly completing a great world wide system of radio communication, which is linking to the great centers of culture and commerce many peoples who are now isolated.

In completing this system of intercourse, I think we shall have accomplished more than all the wars in history to insure and perpetuate peace on earth.

Let us put the situation on a more practical basis. Let us suppose that $5,000,000 were placed in your hands with instructions to spend it to the best possible advantage in securing the peace of the world. What would you do with it?

That very problem confronts the trustees of a fund established by the late Andrew Carnegie, with just such a purpose and just such instructions. Among the trustees are such men as Elihu Root, Nicholas Murray Butler and other leaders of our day who have given deep thought to the problem of how world peace can best be assured. How are they spending the money?

Five million dollars is a lot of money. But measured in relation to the immensity of that problem, it dwindles to insignificance. But the use of this fund has had very definite and apparent results. It is being spent *to promote free intercourse and understanding between peoples.*

Communication leads to understanding and understanding leads to peace.

Keystone View Co.

A GERMAN LINK IN THE RADIO NET

A corner of the great station at Nauen, which was opened in 1920, and which is regarded as one of the finest stations in the world.

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What more practical way could be found, then, to promote peace and good will on earth than to provide the physical means for communication between nations. If I had $5,000,000 to spend in promoting the peace of the world, I would invest it in some enterprise for extending radio communication—and with a perfectly clear conscience.

Of course, I do not pretend that such altruistic motives alone have inspired the present world program of radio expansion. Dreams are worth nothing if no accomplishment comes of them; and accomplishment is built of more solid stuff. Radio communication is reaching out to every nook and corner of the globe because there is a definite demand for such communication and the enterprise can be operated at a profit. Those who will profit most immediately from the extension of radio service are the commercial interests which will make most use of it. But this fact makes radio none the less a useful instrument for the fulfillment of higher motives.

Underwood & Underwood

GENERAL HARBORD BROADCASTS A BALL GAME

The author of this article, snapped at Franklin Field in Philadelphia, while talking into the microphone through which the side-line reports of an Army-Navy football game were sent.

It has been said that commerce follows the flag. It is more literally true that commerce follows communications. And commerce not only stimulates the flow of the material things of life between nations, but it engenders a stream of human thought, and brings men into closer contact and sympathy.

Broadcasting by telephone is but one of the marvelous developments of radio in the past few years. Although the public has heard less of it, there has been a parallel and quite as wonderful expansion of the radio telegraph. Until the war, the radio telegraph was used chiefly as a means of communication between ships at sea and between ships and the shore. Those shore stations which existed were for marine use. It is true that messages were exchanged across the Atlantic but there was no commercial radio traffic to compare with that handled by the submarine cables. The American Expeditionary Force in France first demonstrated the commercial possibilities in radio in establishing the great radio station at Bordeaux. For the first time a station was built purely for connecting two land points, and during the later days of the war this station worked twenty-four hours a day, handling the vast volume of official business between General Pershing's headquarters and Washington, and besides transmitted a good share of the news so eagerly awaited at home.

Since the Armistice there has been a remarkable expansion of radio telegraph

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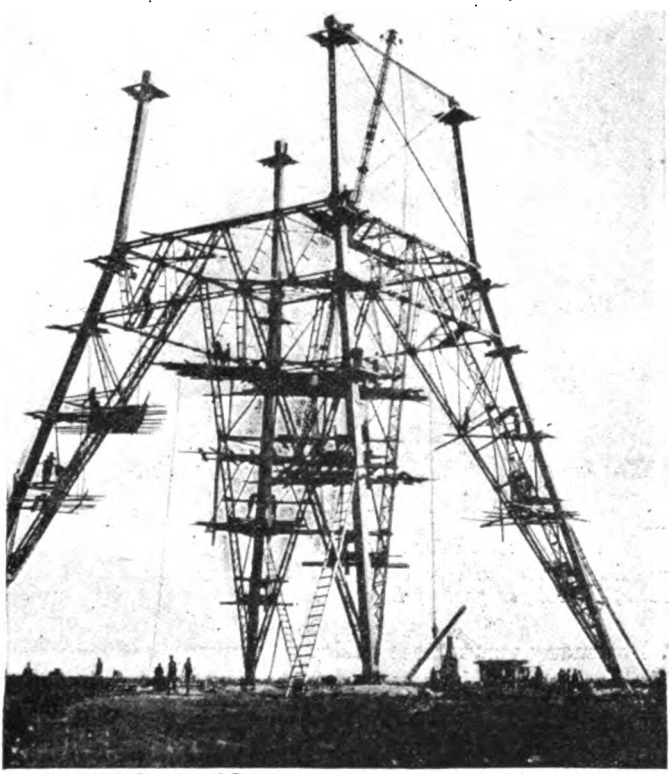

American-Polish Chamber of Commerce

ONE OF THE GREATEST ANTENNA TOWERS EVER BUILT

One of the ten great structures of its kind that are being constructed in Poland, that will enable that nation to enter the new world of the ether.

all over the world. England and France have built extensive systems to link the home countries with their distant colonies. Germany, stripped of her possessions, has concentrated on a great system of internal radio communication.

At the present time the Radio Corporation of America operates six great transmitting stations on the Atlantic Coast for trans-oceanic traffic and all of them are connected by land wires with a central office in New York where the transmitting and receiving actually takes place. These stations now provide direct communication with England, France, Germany and Norway. Other stations now contemplated or under construction in foreign lands will link New York with the Argentine and Brazil in South America, and Poland, Holland, Italy and Sweden.

Across the Pacific, a station in San Francisco now provides communication with the Philippines and Japan, by way of Hawaii. Three large stations are being constructed in China and a service to Australia is being planned.

Although many of these projects are being carried out in co-operation with foreign governments or corporations, the plan and leadership is typically American and it is America which is the focal point of all of these circuits of the ether. No other country has such a program under way.

Perhaps, here, I ought to clear up one or two points of doubt. What of

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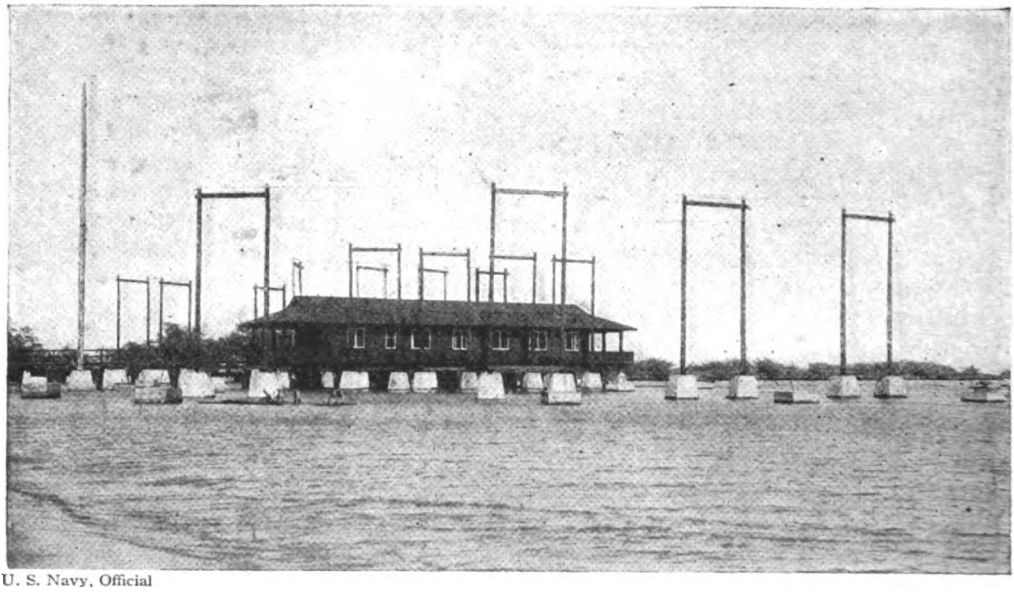

U. S. Navy, Official

A RADIO STATION BUILT ON CONCRETE PILES

This remarkable station was built by the U. S. Navy at Wailupe on the island of Oahu, Hawaii, as part of Uncle Sam's radio system that encircles the globe.

the cables?. For many years these cables have provided an invaluable means for international communication. But a cable is expensive to lay and it is justified only between points where there is heavy message traffic. There are seventeen transatlantic cables and nearly all of them run between New York and London. So far the commercial development of the radio telegraph has supplemented and paralleled the submarine cables, but the chief advantage of radio lies in the fact that it can be utilized between points where a cable would be economically impossible. I have not the slightest expectation that radio development will make the cables any less useful, but I do expect the radio to far surpass the cable in usefulness to mankind.

Another point on which there is much popular confusion is the value of the radio telephone for talking overseas.

Because the telephone has so far surpassed the telegraph on land, many people expect it to do so in the field of radio communication. Already successful experiments have been conducted looking to the early establishment of a radiophone service to Europe, and undoubtedly we shall have such a service.

But consider the fact that while a message is being transmitted by radio, whether by telephone or telegraph, some $15,000,000 or $20,000,000 worth of equipment is tied up. The cost of the message depends mainly on the time required for transmission. Now we have perfected and in daily use automatic machinery to transmit messages by telegraph at the rate of from 100 to 200 words a minute. Of course, no one can talk as fast as that, so the cost of a telephone message by radio will be correspondingly greater. For the present, at least, the radio telegraph will remain the main dependence in inter-continental communication and the telephone will be restricted to that class of messages where the cost is a minor consideration. As to laying telephone cables on the floor of the sea, in the present state of the art, this is impossible, excepting for very short distances.

While the dots and dashes of the Morse code may be less romantic than the projecting of a human voice

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through the ether for thousands of miles, the results will be no less important. And what will be the results?

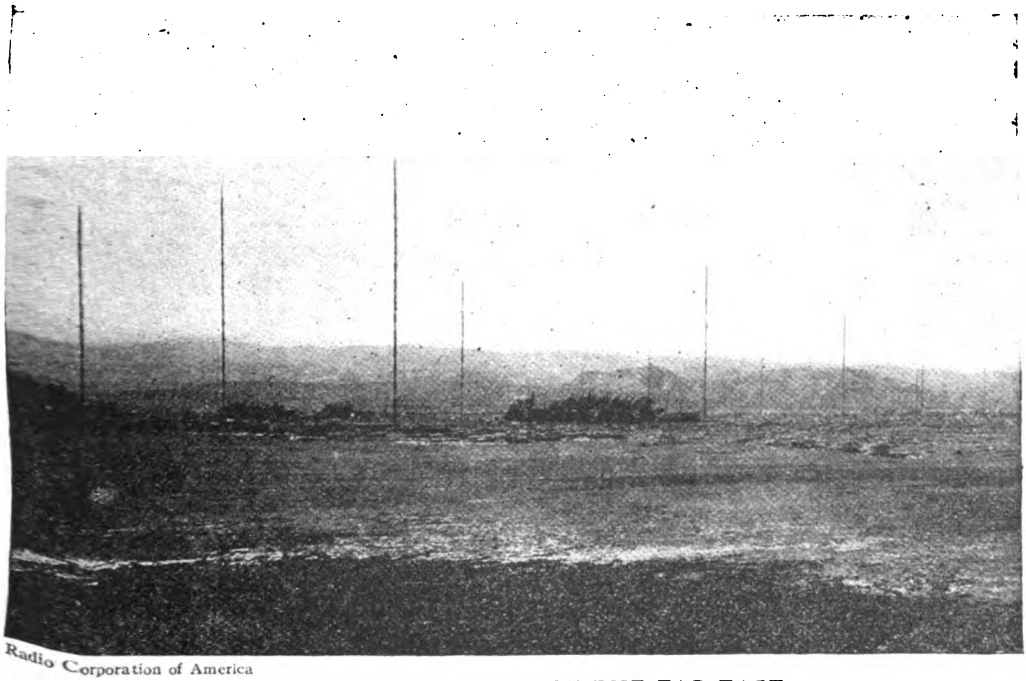
The first and most noticeable result must be a very great advantage to American foreign commerce. Just as London has been the center of cable communication with great advantage to her commerce, so New York is the center of radio communication and American business will profit from that fact. We are finding it increasingly easy to do business beyond our own shores as the ether circuits are extended, and the completion of these new services will mark, I believe, the beginning of a new era of expansion of American foreign commerce.

But it is the social and political, rather than the economical results, which most intrigue me. Among the first and largest users of each new lane of communication are the press bureaus which serve the world's newspapers with the very latest news of the day.

Linking up two countries by radio invariably means that the press service to both is improved in volume and accuracy. The people of each come to understand each other better, as they hear more of the happenings from abroad.

There is a specific example in the case of Japan. More news and more reliable news of each country has appeared in the press of both the United States and Japan since the establishment of radio service, and I feel confident that the improved political relations between the two countries in the past few years is due in no small measure to that fact.

Travelers in Australia often have had cause to complain of the inadequacy of the news from America. That is no fault of the Australian newspapers. Likewise, the dearth of news about Australia in our own press is not be-



Radio Corporation of America

THE ETHEREAL VOICE OF THE FAR EAST

The slender antenna masts of the Japanese station KGI, in Kahuku, each about 300 feet high. They support many miles of wire that are necessary for high-power, high wavelength transmission.

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cause happenings there are uninteresting, but because there is no direct means of communicating the news.

Direct communication between our Pacific coast and China may have even more far reaching results. China, after centuries of lethargy, is awakening under the persistent influence of western civilization. Particularly the influence of America has been felt there.

This has been due, in some measure at least to America's passion for "uplifting." We think of the Chinaman as an inferior being. But there is no basis for such an assumption. Some scientists, who have studied the matter carefully, have concluded that the oriental mind is just as keen as the occidental, and, given equal opportunity, the yellow race may prove just as progressive as the white. Closer contact with our civilization through the agency of radio will undoubtedly speed up the rejuvenation of China's own. Just what the results will be I cannot forecast.

I have often heard it remarked, upon casting a mental glance over the troubled face of this earth, that we are about to sink back into another series of Dark Ages. If the old admonition "As ye sow, so also shall ye reap" was literally true, the outlook would appear gloomy enough. But as a matter of fact the modern world is just beginning to reap the harvest sown by the Newtons, the Huxleys, the Darwins, and all of the other searchers after knowledge in the past. And one of the fruits of this harvest is radio, which, I believe, will develop into the greatest and most practical medium for bringing about international understanding and peace that the world has ever known.

Dorein Leigh, London

THE "LISTENING-IN LOUNGE"

That is the term applied to that corner of the rest room which a London department store has equipped with a radio set for the entertainment of its customers.

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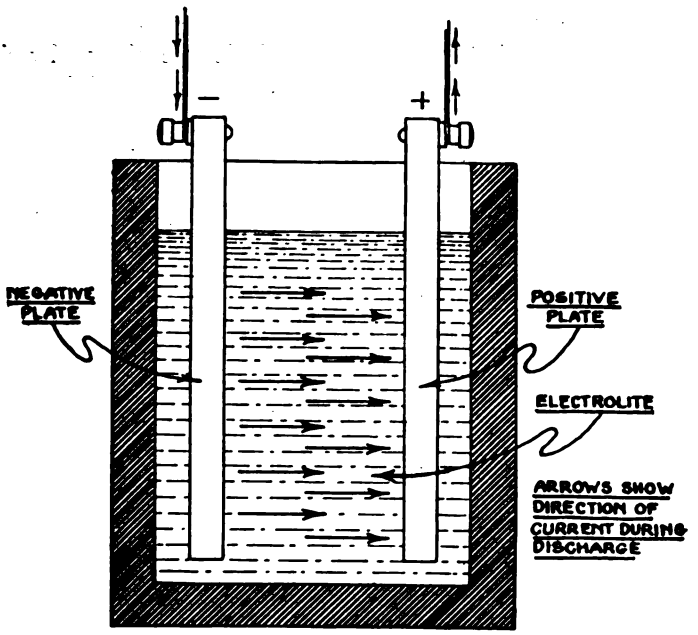

HOW A BATTERY DISCHARGES

FIGURE 1: *When a battery discharges the current flows outside the battery, through the circuit, from the positive terminal to the negative terminal. The flow inside the battery is from the negative to the positive, through the electrolyte, as indicated by the arrows.*

HOW TO MAKE A

Battery Charging Rectifier

At a Cost Ranging from $1.00 to $2.00

By ARTHUR R. NILSON

THE charging of the storage battery is a problem that has to be solved by every radio enthusiast who operates a vacuum tube set. A storage battery may well be compared to a living organism, which soon dies and must be discarded if it is neglected. On the other hand, a little regular care, water and food—which in the case of the storage battery is water and charging—prolongs its life over a long period.

When a storage battery is discharging, the acid in the electrolyte (liquid) mixes and combines with the active material of the plates. For this reason the specific gravity of the electrolyte, which depends entirely upon the ratio of acid to water, varies as the battery becomes charged and discharged. When the battery has completely discharged most of the acid has gone from the water and combined with the plates, leaving an electrolyte that consists largely of water.

When the battery is charged the reverse action takes place; the acid is driven out of the plates back into the water. If all of the acid is not thus driven out, the battery is not completely charged. If this happens a number of times the acid tends to clog up the porous active material (spongy lead)

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of the plates and the battery becomes sulphated.

It is seen that the route taken by the acid is either into or out of the plates and that this direction of movement is controlled by the direction in which current flows in the battery. When a battery is discharging, the direction of the internal e.m.f. between the plates is from negative to positive as shown in Figure 1, and that during charge the flow is in the opposite direction. It is necessary, therefore, that the charging current flow in one direction only; in other words, that direct current be used. An alternating current cannot be used because the direction of flow changes periodically. This is shown in the oscillogram in Figure 2.

In this diagram the electromotive force takes a positive direction for 1/120th of a second and a negative direction the next 1/120th of a second; 1/60th of a second is necessary for a complete reversal of current. Such a current is a 60-cycle current; it is the kind supplied to most lighting circuits.

If a rectifier or some other method of eliminating one direction of flow is introduced in the circuit the pulsating direct current that is shown in Figure 3 results. The lower or negative side of the curve shown by dotted lines is the flow eliminated by the rectifier.

While it is true that the rectified current does not maintain a steady value while flowing, it is uni-directional and therefore suitable for the charging of storage cells.

There are many ways of rectifying an alternating current. Some of the most commonly used and efficient pieces of apparatus are the mercury-arc lamp rectifier, the Kenotron and the Tungar rectifiers, the mechanical rectifier, and the type of rectifier to be described in this article, called the electrolytic rectifier.

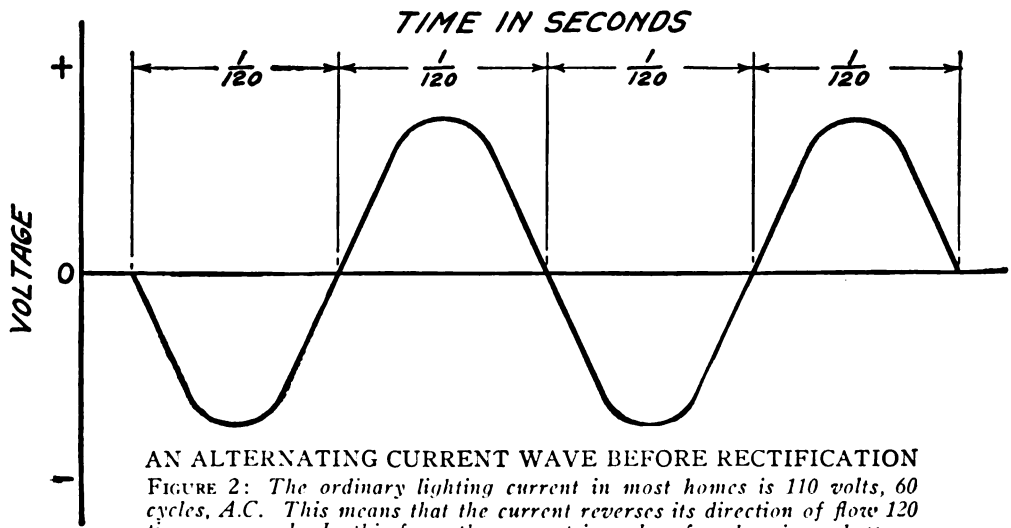
How to Build the Rectifier

The electrolytic rectifier is perhaps the one most easily made by an experimenter who has only a few tools. A photograph of the completed rectifier and resistance is shown in Figure 4. The following materials are necessary:

2 mason fruit jars—pint size;
2 strips of aluminum; size—6 inches by 1 inch by ⅛ inch;
2 strips of lead, size—6 inches by 1 inch by ⅛ inch thick;
A few ounces of borax;
4 terminal posts.

The construction is so simple that a lengthy explanation is unnecessary. A close study of the photograph will show that the two strips are bent and hung over the edge of the jar into the electrolyte.

The electrodes as noted in the list above



AN ALTERNATING CURRENT WAVE BEFORE RECTIFICATION

FIGURE 2: *The ordinary lighting current in most homes is 110 volts, 60 cycles, A.C. This means that the current reverses its direction of flow 120 times a second. In this form the current is useless for charging a battery.*

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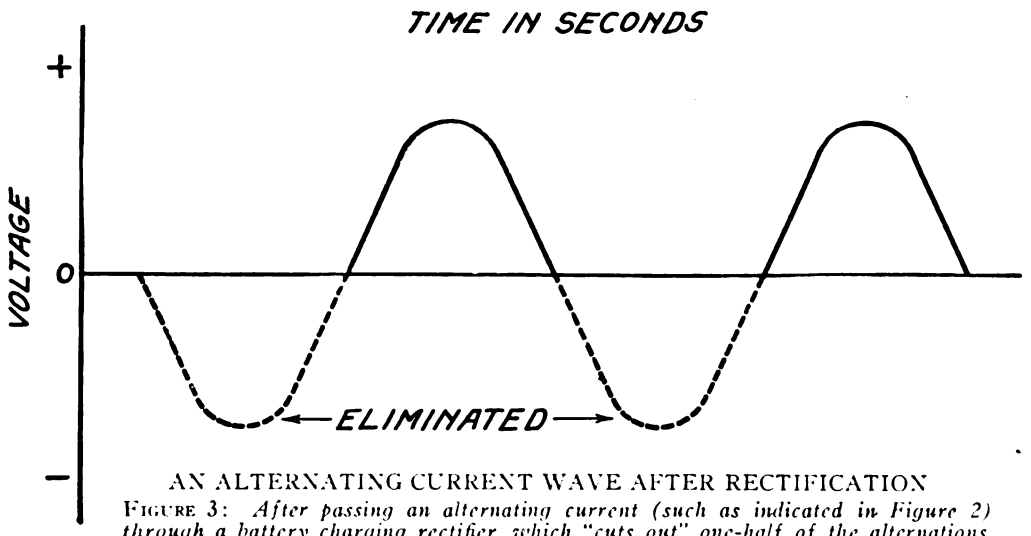

AN ALTERNATING CURRENT WAVE AFTER RECTIFICATION

FIGURE 3: *After passing an alternating current (such as indicated in Figure 2) through a battery charging rectifier, which "cuts out" one-half of the alternations, a pulsating direct current is left which can be used to charge a storage cell.*

are of lead and aluminum, cut to the sizes given in the list.

The electrolyte consists of two pints of water to which has been added about three heaping teaspoonfuls of borax. A new electrolyte should be prepared and substituted every few weeks. This is necessary because the electrolyte becomes saturated with aluminum particles which come off the positive plate and mix with the electrolyte, thereby lowering its resistance. The lead plate does not wear away.

The jars used are the pint size mason fruit jars which may be purchased in any hardware or grocery store.

The terminal posts should be one-inch round head brass machine screws with two nuts. Their size should be 8/32 or 10/32 thread.

The jars should be set into a wooden rack as shown in the photograph. A rack such as the one shown can be made of whitewood and stained any desired color.

How to Operate the Rectifier

While in operation the rectifier "boils" due to the heat produced by the current that flows through the electrolyte between the lead and aluminum electrodes. The water is therefore evaporated and it is necessary to add water to take the place of that lost by evaporation. It is not necessary to add more borax; this element does not reduce itself by evaporation.

A connecting lead-wire to hook the rectifier up to the lighting circuit is necessary. This should be as long as required and should have a screw plug fitted to one end so that it may be screwed into a light socket. Spring clips should be soldered to the other ends for clipping it onto the rectifier and resistance terminals as indicated in Figure 5.

A double-pole double-throw switch to change the battery from charge to discharge will be found convenient and may be connected as in Figure 5.

It is important that the two sets of aluminum plates and the two sets of lead plates be connected together, with the jars paralleled and also that the aluminum strip electrode of the rectifier be connected to the positive terminal of the storage battery. If the polarity is not marked on the battery it may be determined in any of the following ways:

1. Cut a potato in half, and insert the two leads from the battery; a green formation will take place around the positive terminal.
2. A direct current voltmeter will read correctly only if connected positive to positive and negative to negative. Get a reading on the voltmeter and note the markings on the connecting posts.
3. Dip the terminals of the battery into a glass of water into which a little salt has been dropped, being careful not to let them touch; bubbles will appear at the negative terminal.
4. Use a polarity indicator; this may be purchased in any electrical supply store.

The rectifier and storage battery should be installed in the cellar near the electric meter. This, of course, will necessitate running two wires up to the radio set but it removes the possibility of any of the sulphuric acid coming in contact with furniture and carpets.

If the battery is installed in any place where it may injure fabrics or furniture, it should be kept scrupulously clean. It is well, any way, to keep the lead connectors and terminals coated with vaseline. Always unscrew the caps while the battery is on charge so as to allow the gases which are generated to escape.

The generation of gas (shown by bubbling)

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in the electrolyte while the battery is being charged indicates that the battery is nearing the full charge point. After this has been going on for four hours it is safe to assume that the battery is fully charged.

How to Make the "Resistance"

It is necessary to insert a resistance in the line; such a resistance may be a 100-watt lamp or a water rheostat, made as shown in Figure 6.

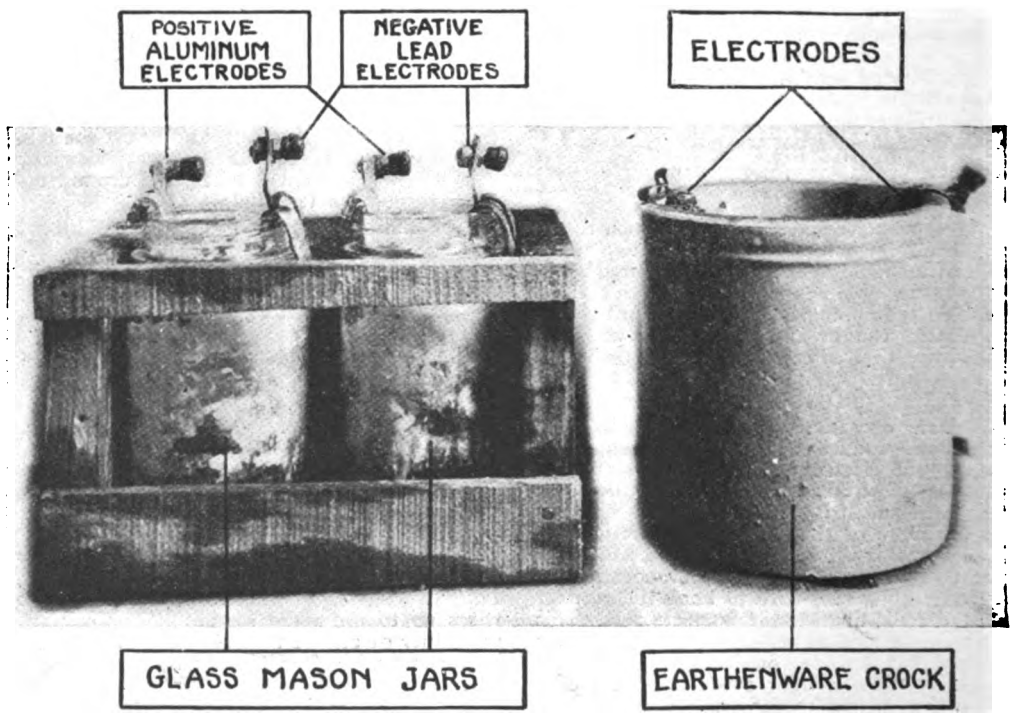
The jar for this should be 6 inches by 8 inches in size. The electrodes should be lead and carbon. Connect the lead to the negative side of the line. The electrolyte should consist of pure water to which has been added a half teaspoonful of salt.

Practical application has shown that only two rectifying jars are necessary for the ordinary 40 or 60 ampere-hour battery. If, however, a battery of larger capacity is to be charged, three jars in parallel may be used to cut down the time necessary for charging. Two jars may be used in any case, but the higher the capacity of the battery the longer the time that is necessary for charging.

Before the completed rectifier is put into use it should be connected across the lighting circuit line for several hours until the plates have taken on a crust or deposit. The plates are then said to be "formed."

This is necessary because the rectifier, when it is first connected to an alternating current line, acts only as a resistance, and if it were connected to the battery without first having the plates formed, it would allow alternating current to flow through the battery.

In other words, the rectifying action of this type of cell depends on the chemical action which takes place in the thin crust or deposit on the aluminum plates, and if the plates are not first formed they will not rectify efficiently.



THE COMPLETED RECTIFIER AND WATER RHEOSTAT

FIGURE 4: *The rectifier jars are set up in a wooden rack, and an earthenware crock is used to hold the electrodes of the water rheostat. With these two units the radio fan may charge his own batteries at home from the A.C. lighting mains at small cost.*

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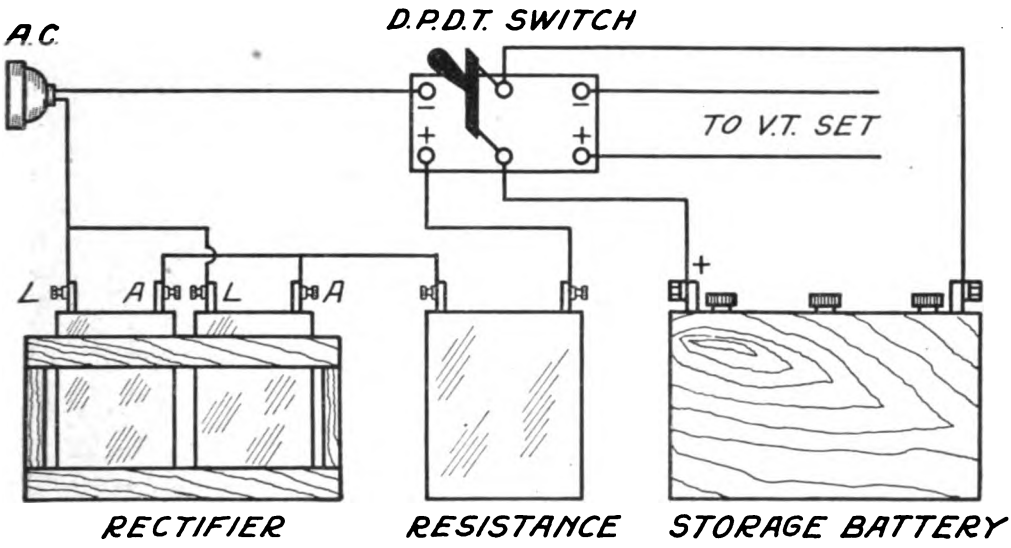


HOW TO WIRE UP THE CHARGER

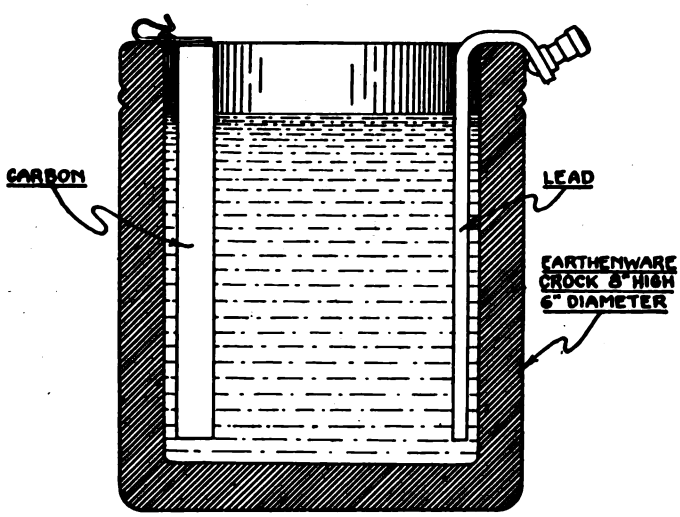
FIGURE 5: *The circuit diagram for connecting up the rectifier, the rheostat, the storage battery and the change-over switch. By throwing the switch to the left the battery is put on charge and by throwing it to the right the battery is connected to the vacuum tube receiving set.*

The only part that has to be replaced in the cell is the aluminum plate, which eats away after a period of usage.

The above type of rectifier has been used for many months by the writer, and it has given him uniformly excellent results and the cost per charge has been extremely low.

HOW THE WATER RHEOSTAT IS PUT TOGETHER

FIGURE 6: *The rheostat consists of an old earthenware crock which is filled with water to which has been added a half-teaspoonful of salt. The lead and the carbon electrodes are then immersed in the liquid on opposite sides of the crock.*



How to Build a Simple Honeycomb Receiver

In the next issue of POPULAR RADIO—for October—will appear a complete detailed description of a home-made set that may be built by any radio novice who is handy with tools at a cost of about $15.

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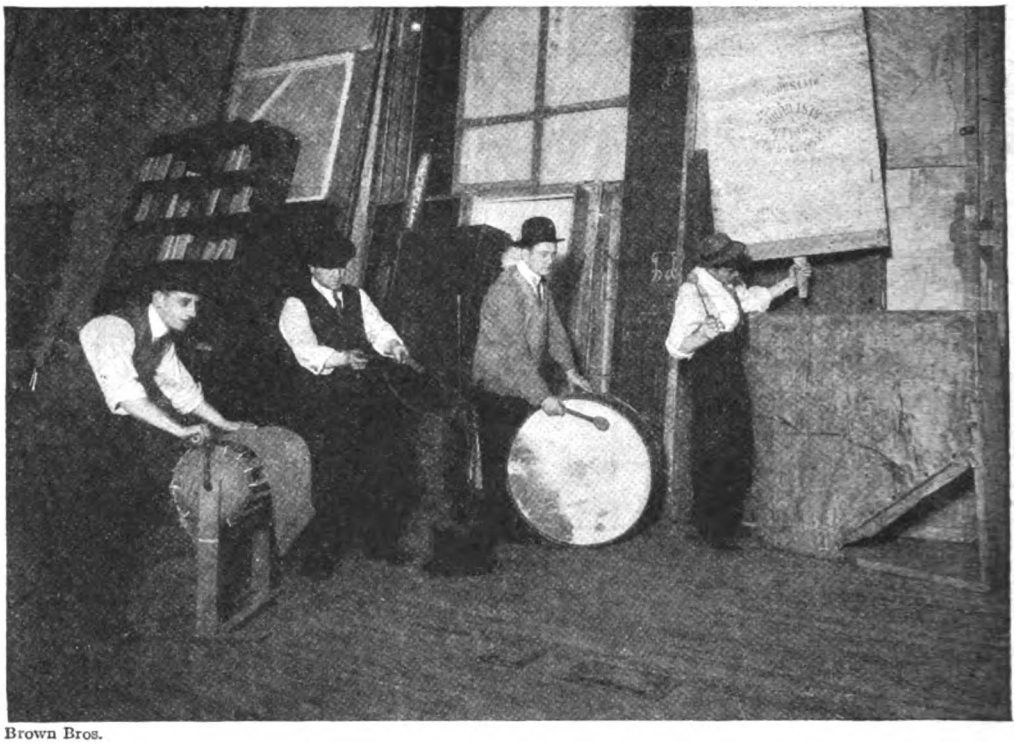

Brown Bros.

IMPORTANT MEMBERS OF THE CAST OF THE BROADCAST PLAYS OF THE FUTURE

The drama that must depend entirely upon sound must differ in its technique from the drama that appeals to the eye as well. The thunder and crash machines and the sounds of galloping horses will, indeed, figure among the thrilling features of the new theater of the ether.

My Drama Is Broadcast

The personal adventures and impressions of an eminent playwright who participates for the first time in a production of a comedy without costumes or "props" in a transmitting station

By JESSE LYNCH WILLIAMS

"Dear Mr. Williams:

I write at my wife's request, to express her great appreciation of the play *Why Not?* broadcast this afternoon. She is confined to the house with a cold, and the play was a perfect treat to her. She heard every word, and the changing voices made it most intelligible. It was a great pleasure to me to hear she had been so well entertained during my absence.

Very truly,

...."

THAT is one of nearly a hundred letters we received after broadcasting our comedy from station WOR, at Newark. They came from all kinds of people, all parts of the east.

One of them was from a farmer's wife in a remote corner of Pennsylvania. She asked me please to tell her whether it "ended happily. Were they reunited at the end of the play?" She

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explained that as she was obliged to go out and milk the cows, she was not able to listen in after the second act. Of course, I wrote and told her about it, because such genuine interest is most flattering to an author, and because she would not be likely ever to see the play, even on the road.

It was a very interesting experience, this broadcasting of a play, and a novel one. Since we did ours, Miss Jane Cowl has broadcast her entire performance of *Romeo and Juliet* with great success, direct from the stage. In our case, however, the entire company made an expedition from Manhattan to the broadcasting station, accompanied by the director, Mrs. Shelley Hull, and the author, myself. The only "stage property" we carried along was a cocktail shaker!

We were conducted in state (and taxi cabs) to the station and were ushered into a sort of a padded cell which they called a studio, though one of our comedians called it "the mortuary chamber." It was a very silent place, draped with curtains to prevent the intrusion of noises from the outside, and, as we found out before the performance was over, it was well nigh air-proof as well as sound-proof. The men perspired and the ladies got headaches.

We were asked to seat ourselves around a small table, about the size of a stand for holding a cigar humidor or a vase of flowers; only in this case there was placed upon it a curious disc-like instrument of which I forgot to inquire the name—it was the transmitter, I suppose. One of the radio experts informed us that it cost three thousand dollars, or maybe it was thirty thousand dollars—I don't remember, but we were all supposed to be awed. And we were. We said, "Just think of that!" and "My! My!"

We were all impressed by this novel experience of presenting our play to the largest audience in the world, not one member of which we could see. But we were impressed in such different ways! The two charming children in our cast have radio sets of their own and they were merely impressed with the interest and excitement of being "behind the scenes" at a radio station—just as ordinary young people, not professional actors, are always excited and impressed when they have a peep behind the scenes at the theater, an old story to the boy and girl in our company. The older members of the cast, however, were moved in a different way. They were not used to radio or to acting without make-up and for an audience they couldn't see. There was something uncanny and uncomfortable about it. They exchanged self-conscious glances, as if they were about to undergo an operation at a hospital and were trying to show one another that they were not in the least frightened. Some of them were frightened, however; one of the most experienced members of the company whispered to me, excitedly, "I would rather go through three first nights than speak my lines into that queer-looking instrument."

"I know I am going to miss my cues," said another. They all spoke in whispers, like people at a funeral.

"Oh, don't worry," said the director. "I have the script here and will prompt you."

"Must we talk awfully loud?" asked one of the ladies.

"Oh, no, just use your natural speaking voice," said the calmly smiling official in charge.

"My natural speaking voice is gone," she gasped. "I feel as if I couldn't do anything but swallow." And she swallowed.

"Have a glass of water," said I. So she swallowed that and felt better.

I, too, was affected strangely by the experience, but in an entirely different way. I had been informed the day before that it was up to the author to start the ball rolling by making a speech in regard to the Equity Players, the

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"STATIC" FROM A COCKTAIL SHAKER

When this crucial scene was broadcast from the studio of WOR, a coin was used in the shaker to take the place of the ice. But the noise so closely resembled the sounds produced by static that the transmission room was thrown into consternation!

theatrical organization producing my play, and also that I must say something about the play and the players and describe the scenes which otherwise those "listening in" could not understand.

Now, if there is anything I hate and fear, it is speech-making. I never do it when I can avoid it and have been known to take a trip out of town for the express purpose of escaping such ordeals. But in this case it was put up to me in such a way that I could not escape. So the morning before we went over to Newark, I wrote a number of nice extemporaneous remarks.

But now when I was called upon to begin, a curious thing happened. Although I knew that there were between a quarter and a half a million people listening to me, I was as cool and collected as I am at this moment, writing this article! The reason was that I simply could not see any of you—for I take it that some of you who read this must have been among those present, or rather absent—that is why you did not rattle me. I simply read from my manuscript, knowing comfortably that nobody could see me read it. I was so cool that I even ran in one or two remarks that were really extemporaneous.

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It was a great surprise to me as well as to my good friends of the company, who know my aversion to appearing before the footlights when unkind acquaintances in the audience, who also know how poor I am at that sort of thing, call "author! author!" at first nights, in order to scare me to death.

After making my "speech" (which I will say had the virtue of being short), it devolved upon me to introduce each member of the cast. I would read a description of the character and then state that it was to be played by Mr. or Miss So-and-so, adding:

"Ladies and gentlemen, it gives me great pleasure to introduce Miss Blank."

Whereupon Miss Blank would say to three or four hundred thousand fellow-citizens, "How do you do. I'm sorry I cannot see you," which would give me an opportunity to add, "I am more sorry that you cannot see *her*—she is very beautiful"—or something of that sort. We actually got some fun out of the ordeal.

Then with the ringing of a soft-toned gong, to indicate the rising of the curtain, the action began. Of course, I cannot describe all that, except to say that the voices "came over" most successfully, as we afterwards learned from the many letters referred to. Probably one reason, in addition to the fact that they were well-trained voices, was that *Why Not?* is a comedy and, therefore, all the cast spoke conversationally, rather than oratorically or emotionally. One of the officials at WOR told me that certain lecturers and speechmakers are hard to hear because they become so worked up and eloquent that they shout and therefore their voices become blurred and indistinct.

There was one other problem we had to meet. Plays, of course, are not written merely to be ***heard*** but to be ***seen***. For those listening in, there was nothing to indicate the exits, the entrances and the "stage business." For example, two people would be playing a scene and presently, without any apparent reason for it, from the point of view of those listening miles away, a third voice would suddenly butt in. I should think it would have been quite confusing, and I was surprised that our listeners were so kind in their comments in regard to this.

If I ever broadcast another play, I shall either write in some new material to take care of such contingencies, or else I shall have somebody on the job, even though I have to do it myself, to say to those listening, "At this point his daughter is seen entering from the garden. . . . Now she is looking all around the room for her father. . . . Now she discovers him, smilingly hiding behind the screen."

I have mentioned that a cocktail shaker was the only "prop" we took along with us. This was because the mixing of a famous cocktail plays a very important part in the first act of *Why Not?* The hero of the play is a gentleman in reduced circumstances, who, in order to get his adorable little daughter out of the hot, hateful city into the wholesome air of the country, impersonates a servant and secures a job as a butler in a large country house. His wife, equally a good sport, secures the position of parlormaid.

The play opens with her putting him through his paces as a butler, a sort of rehearsal of his new rôle. But he is a man of education and taste, and finding a discordant combination of colors in the flowers in the room, "pink and yellow together," indignantly dumps the pink roses into the coal-scuttle. Subsequently, they are found there by a caller who happens to be the friend of the family who had sent the flowers and didn't know any better than to commit this "crime in color." He, therefore, indignantly orders the new butler to put the roses back into the vase, but the butler refuses to do anything of the sort and finally, forgetting

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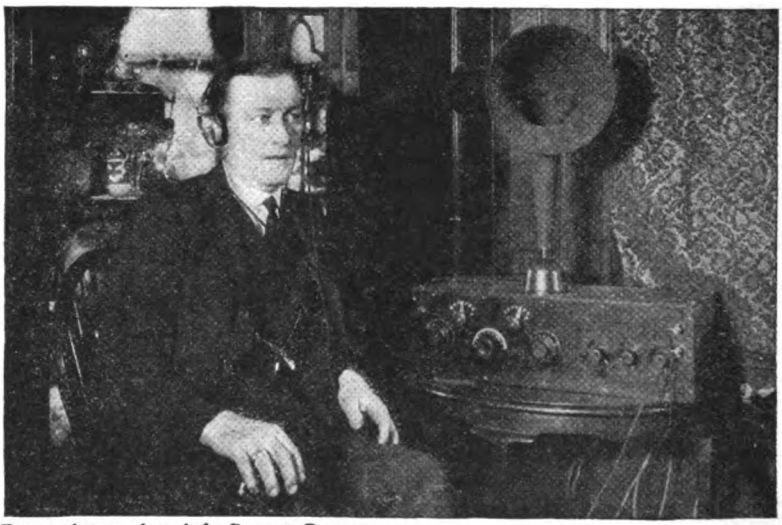

From a photograph made for POPULAR RADIO

THE STAGE MANAGER LISTENS IN

The expression of mingled amusement and surprise is created by the hearing of the familiar voices which he had heard before only from behind the scenes of the theater.

his part and his place, tells the caller to "go to hell."

Later in the act, the new butler is about to be discharged by the master of the house for being "impertinent to one of our guests." The mistress of the house, however, is the woman this pseudo-butler had loved in his youth, but had fled from, although she loved him, too, because, as he tells her in the love scene, "you were so enormously rich and I was so romantically poor." She doesn't want him to be dismissed. She remembers that in the old days he had been pronounced by her father a great artist at mixing cocktails. Her present husband is also a connoisseur in cocktails—in consuming them, that is, not concocting them. So she suggests that he try one of the new butler's cocktails before the decision to discharge him is final. The master of the house agrees that if the new butler's cocktail proves to be a really notable success, his position will remain secure. So, with great elaboration and considerable comedy, the wonderful cocktail is composed upon the stage, tasted, tried a second time and pronounced a work of art. The situation is saved.

Now as we play it at the theater, real ice is used as well as grenadine to give the water (which plays the part of gin) a pleasing color, but as none of this, of course, could be seen during the broadcasting, instead of ice a couple of coins were placed in the otherwise empty shaker. At the proper moment, with the accompanying dialogue, the gentleman-butler began to shake it. In the studio where we sat around the transmitter, the noise of the coins in the shaker, deadened by the hand of the actor, gave a very good illusion of the gladsome sound of a cocktail coming into the world. But in the broadcasting room up on the roof, where an expert was regulating the waves (or whatever it is such experts do), this sudden and unexpected sound caused great consternation. "My God! Static!" he muttered and excitedly began pulling out stops like organ stops, adjusting multipliers and variable condensers, or whatever it is they adjust when "static" is heard.

It was not until after the play was finished that the expert discovered that he had been endeavoring, like Mr. Volstead, to suppress cocktails. Fortu-

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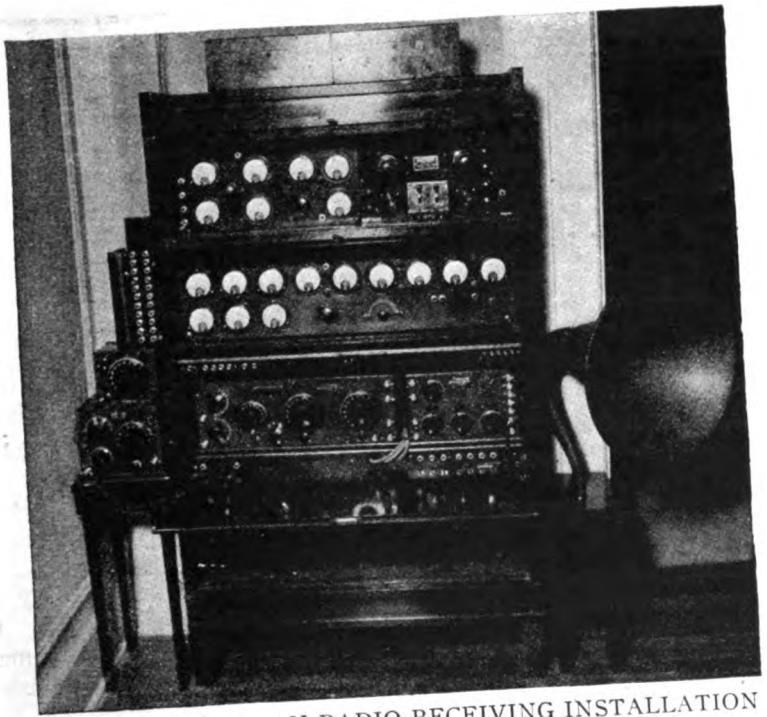
nately, as in the case of Mr. Volstead, his efforts were not successful. So the joke was on him—again like Mr. Volstead.

I referred at the beginning to that valuable transmitter (if that is really the name; I don't know any of the technical terms, but I hope my children will not read this article, because I should hate to have them ashamed of their father). We were all very much in awe of it, even before the experts told us that it cost three million dollars —or whatever was the impressive price. During the intermission, at the end of the first act, the boy member of the cast, who plays the part of Billy, being a great radio fan, like most modern boys, drew near to admire and examine it. One of the officials was explaining its unique virtues. My back was turned at the time, but suddenly I heard a horrible crash and turning beheld there upon the floor the thirty million dollar transmitter, broken to bits. There was a second's awful silence. I thought, of course, that our boy actor had dropped it. Terrible visions of life-long indebtedness arose before us.

"That was very awkward of me," said the official, and I breathed again. He had done it, not the boy. He rang for his assistant, sent up to the broadcasting room on the roof for another, and in five minutes we went on with the second act.



AN ALMOST HUMAN RADIO RECEIVING INSTALLATION

With voltmeters and ammeters for each circuit to measure the currents flowing and check up the voltages, and with duplicate sets of "A" and "B" batteries both of which are minutely variable, this set, which employs both radio frequency and audio frequency amplification as well as two stages of power amplification, is so complete that it takes but little effort on the part of the operator to keep it working efficiently. Batteries are charged, cut in and out of service, a number of antenna systems interchanged at will, and any amount of amplification put into service by merely pushing in or pulling out the control plugs, that master the maze of complicated circuits in the interior of the sectional bookcase in which the instruments are mounted. The set is the property of C. E. Pettit, of Stuttgart, Arkansas.

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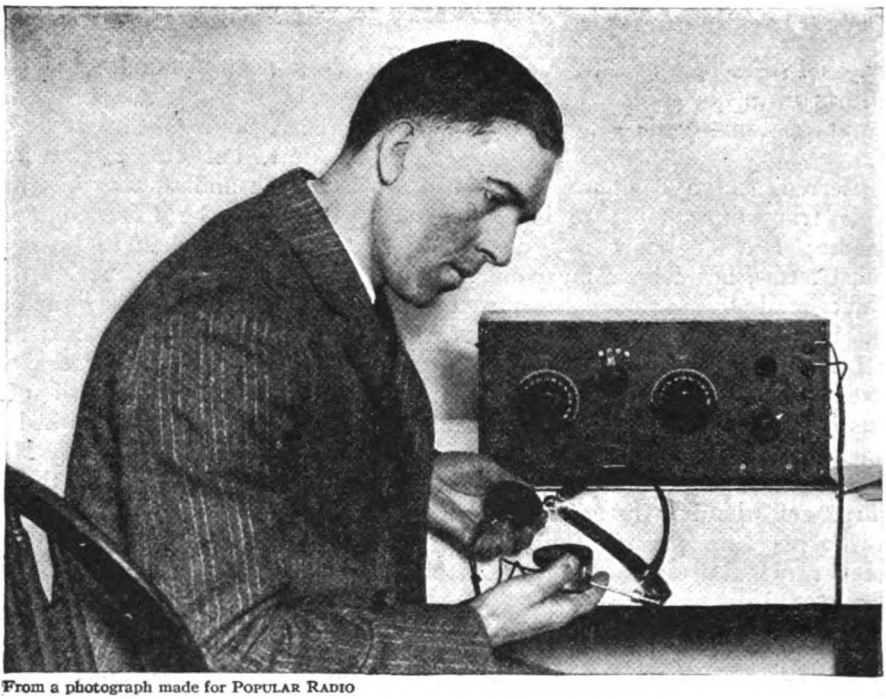

From a photograph made for POPULAR RADIO

SIGNALS FROM LOCAL STATIONS CAN BE HEARD SEVERAL FEET FROM THE EARPHONES

The author shows how to set the dials for the initial tuning operations; he has tuned the receiver to 360 meters.

HOW TO BUILD THE

HAYNES DX RECEIVER

This remarkably efficient long distance set may be built by any inexperienced novice who is handy with tools, at a cost of approximately $15. How to do it is described here in detail by—

LAURENCE M. COCKADAY, R. E.

MOST of the radio receiving circuits that have stood the test of time and are in general use today fall into one of two classes as follows:

1. *The single-circuit regenerative tuner,* so called on account of the single-tuned circuit employed, is being incorporated in a good many receivers manutured by well-known radio concerns. It is supplied in an attempt to meet the demand for a receiver that is easy to operate and on which fairly good long distance work can be done. It has the advantage of low cost of manufacture due to the few instruments used and the simplicity of the wiring.

The tuner, however, has two marked disadvantages which prevents it from becoming very popular.

The first is a lack of selectivity. Hence, along the seacoast or near a metropolis which has one or more high

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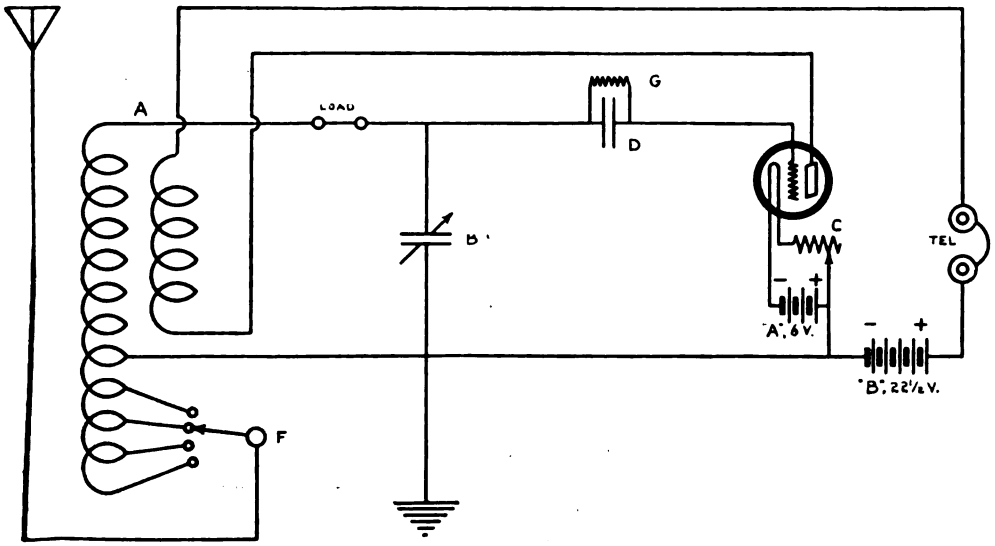
power radio telegraph stations or where several broadcasting stations are operating, this type of circuit is hardly practicable, due to the great amount of interference prevalent.

The second disadvantage is that this circuit is an interference producer; that is, it is a transmitter while oscillating and sends out a strong C.W. wave which interferes with the reception in neighboring receiving sets.

2. *The three-circuit regenerative tuner* receives its name from the fact that it contains three separately tuned circuits. It is an extremely good receiver capable of doing fine work in the hands of an experienced operator. It possesses efficiency and selectivity to a marked degree. But—it is a hard circuit to learn to operate properly. Unless the operator knows *what* he is doing and *why* he is doing it, he cannot hope to obtain the best possible results. Moreover, due to the several instruments used, it is rather costly and somewhat complicated in mechanical construction to say nothing of the complexity of the circuit and the difficulty of wiring it properly. While many radio experimenters build sets of this type which give them good results, it is seldom that one of these home-made, three-circuit receivers operates at maximum efficiency. This is because in such a receiver, so much depends upon small details in design and construction and careful balancing of the various circuits, points which require the knowledge and experience of a good engineer.

In the Haynes circuit, which is described here, practically nothing has been sacrificed. It is not a compromise, but possesses most of the good points of both of the above circuits with none of their disadvantages. The tuning is simple; similar to that of the ordinary single-tuned circuit. At the same time it is selective, making it possible to reduce interference to a minimum. Furthermore the audibility or strength of signals from nearby or long distance stations is as good as in the three-circuit tuner.

Figure 1 is a schematic diagram of the new simplified regenerative circuit. Those familiar with radio diagrams will recognize the similarity of this hook-up



THE ELECTRICAL CONNECTIONS FOR THE PARTS USED IN THE CIRCUIT

FIGURE 1: *The parts are here designated by the same letters that designates them in the text of the article and in the list of instruments.*

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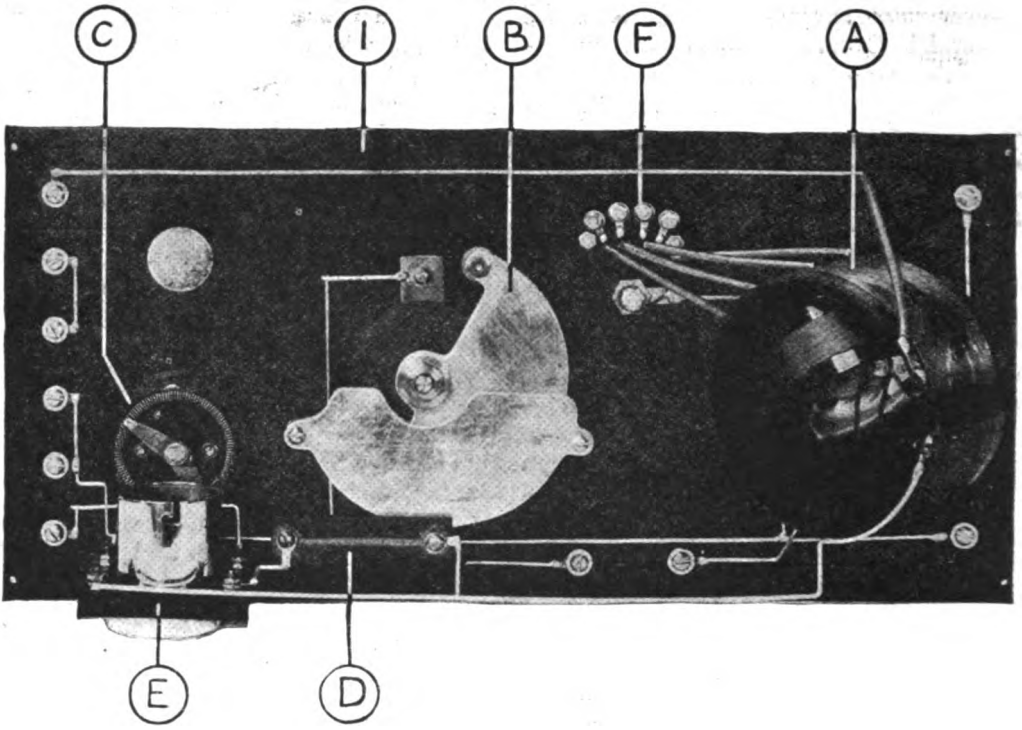

A REAR VIEW OF THE RECEIVER

FIGURE 2: *This picture of the interior of the set gives the novice an idea of the arrangement of the parts and shows him more clearly the exact connections than does the electrical diagram on the preceding page.*

with that of the regular triple coil, tickler feed-back circuit—with one exception: *The primary circuit is semi-aperiodic* and is conductively coupled to the secondary grid circuit.

The primary circuit consists of the first few single-tapped turns on the stator or stationary winding of a variocoupler while the remainder of this winding is used as a secondary. The rotor or movable coil is used as the tickler. One of the 180° type couplers is best, as it gives a much smoother regenerative control. Some of the winding should be removed from the rotor, leaving on about 35 turns for the average detector tube. A special coupler of this type is used in this circuit. This coupler has a low resistance stationary winding properly tapped. When used in this circuit it gives exceptionally sharp tuning and great signal strength. Ordinary 180° couplers with the usual number of turns on rotor will not be satisfactory.

The heart of the circuit is the secondary tuning condenser. The best obtainable variable condenser should be used here, as a cheap one, particularly in this circuit, is very poor economy. Its maximum capacity should not be greater than .00023 mfds. A larger condenser makes the tuning too critical. For best results the condenser used should have a *low minimum capacity.*

Many modifications may suggest themselves to the builder to meet his particular fancy. However, the specifications given in the following instructions will produce an exceptionally good receiver for both amateur and broadcast reception.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in

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the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below.

The list of parts includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with excellent results.

All instruments listed are capable of panel mounting, making assembly a very simple task and providing a particularly neat lay-out.

A—Haynes 180° bank-wound variocoupler;
B—Haynes variable condenser, .00023 mfd;
C—Fada rheostat, 6 ohms;
D—Micadon fixed condenser, .00025 mfd.;
E—Fada panel-mounting socket;
F—switch and switch points;
G—tubular grid leak, 2 megohms;
H—binding posts;
A1—three-inch knob and dial;
B1—three-inch knob and dial;
I—composition panel, 7"x15";
J—cabinet;
connecting wire;
varnished cambric tubing.

How to Construct the Set

The first step in construction is to prepare the main panel I.

Almost any of the good, standard panel materials are suitable for this purpose.

If a dull or satin finish is desired on the panel, it may be done as follows:

After drilling has been finished, following the instructions and dimensions in Figure 3, a small quantity of ordinary machine oil is placed on the front side of the panel, and it is then rubbed with a fairly fine grade of emery cloth or steel wool. Rub in only one direction, back and forth lengthwise of the panel. When the surface has attained the desired finish, the panel should be cleaned off with a dry cloth, taking care to remove excess oil from the holes.

The builder can either have the panel engraved, and this is advised, as it adds to the appearance of the set immeasurably, or he can simply scratch indicating lines for the dials with a sharp pointed scriber and a ruler, filling them in with "flake white."

If the panel is to be "dulled" or "grained" as explained above, it may be laid out for drilling by using a sharp pointed punch or scriber. Guide lines may thus be scratched directly on the panel, where necessary, and punch marks made at points where holes are to be drilled. Care should be taken of course, that these lines are not scratched too deeply, so that they will disappear when the surface is rubbed down.

Next, mount the variocoupler A, by screwing onto the panel I, in the position indicated in Figures 2, 4 and 5, and attach the knob and dial A1, by means of a set-screw.

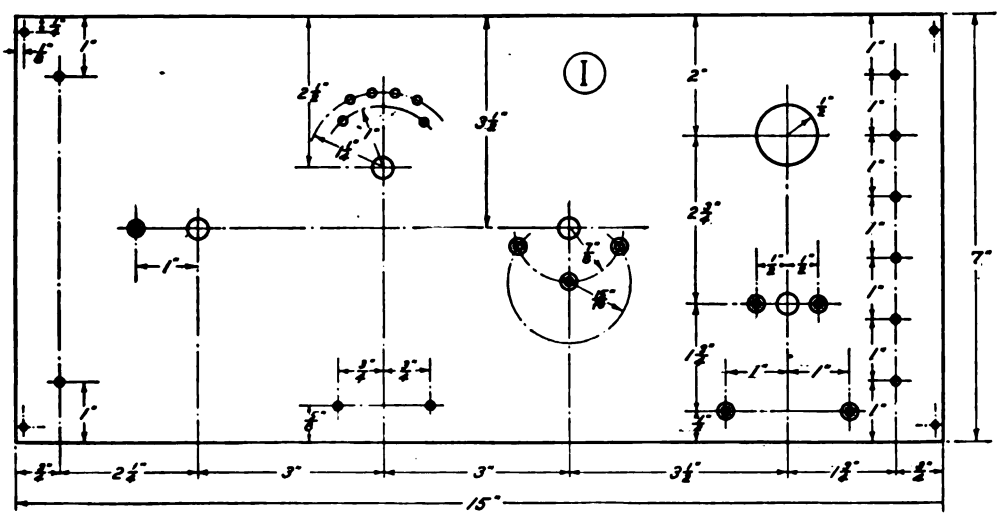
Then attach the condenser B, to the panel with three screws and put on the knob and dial B1, as shown in Figures 2, 4, and 5.

The socket E, may now be screwed to the panel as shown in Figures 2, 4, and 5.

Attach the rheostat C, and small knob C1, in the manner indicated in the drawings in Figures 4 and 5, and fasten the binding posts H, which are screwed to the panel by round head screws.

The small fixed condenser D, is supported by the wiring and this may be left until the set is connected up.

The last construction job to do is to mount the switch and switch points. This should be done as shown in Figures 2 and 4.



THE LAY-OUT OF THE PANEL

FIGURE 3: *This diagram gives the dimensions for the panel I and the spacing for the drill-holes for mounting the instruments that are specified in the text.*

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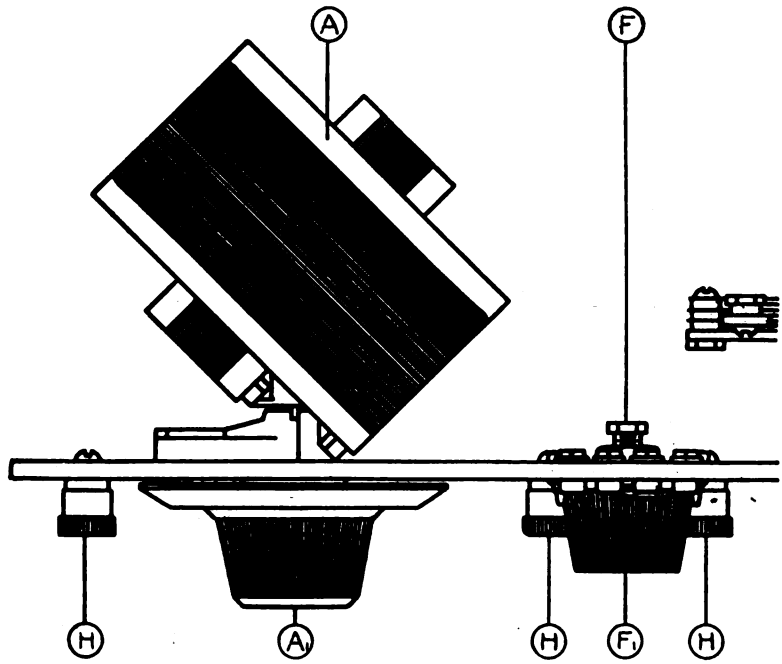
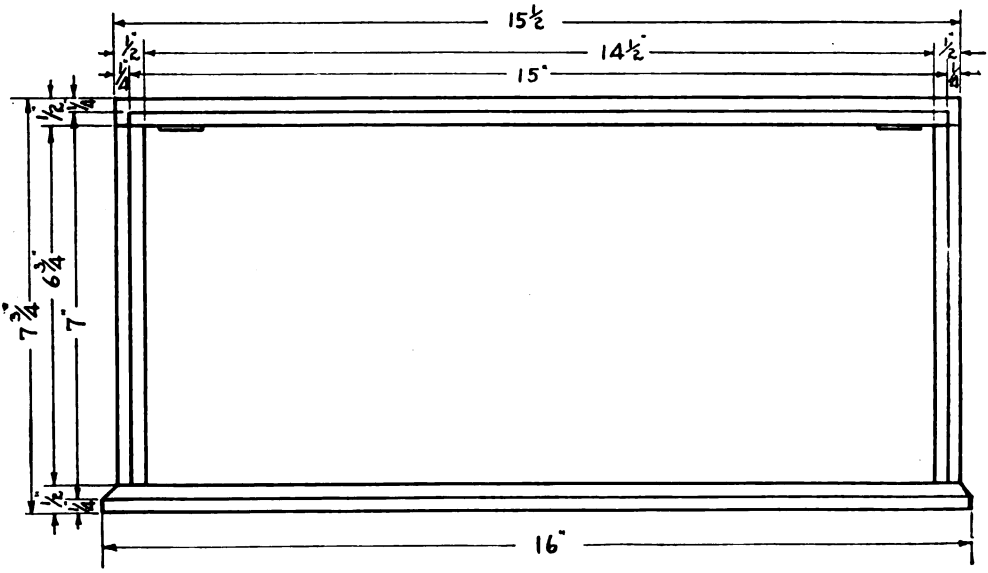


THE WORKING DRAWING SHOWS HOW—

FIGURE 4: *A view of the set from above, showing the exact positions for the coupler, the condensers, the rheostat, the switch, the socket and the binding posts. The instruments will fit exactly as shown on this diagram if the drilling plan drawn in Figure 3 is followed out exactly.*



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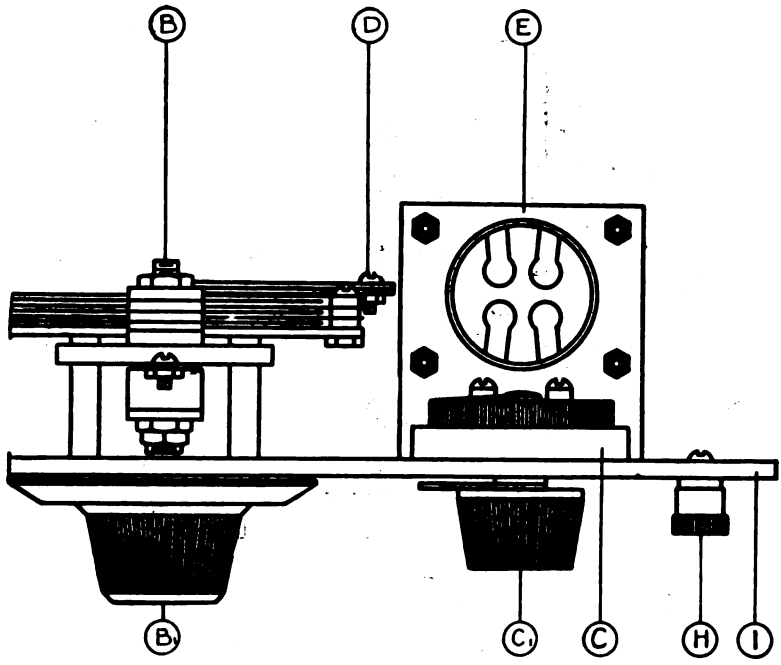
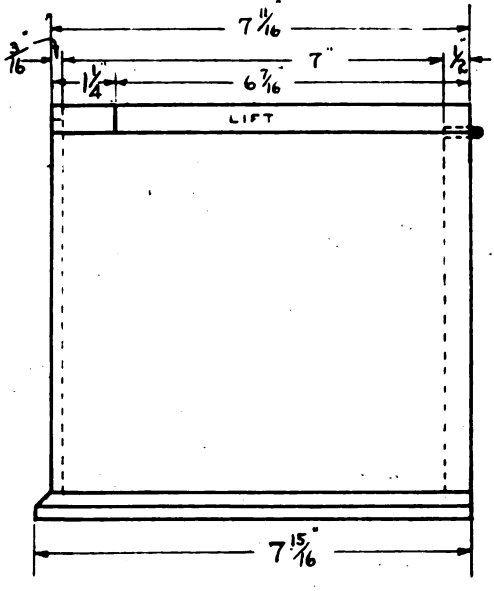


—TO PLACE THE INSTRUMENTS AND ASSEMBLE THE SET

It is recommended that the plan shown here be rigidly followed, as it has been carefully worked out and the instruments have been placed in their respective positions, as shown above, with a definite purpose in view—efficiency.



HOW TO BUILD THE CABINET

FIGURE 6: *The drawings at the left give the detailed instructions and dimensions for building the cabinet—which you can make yourself or which can be turned over to a cabinet maker. It should be finished in hardwood and polished or buffed according to the taste of the builder.*

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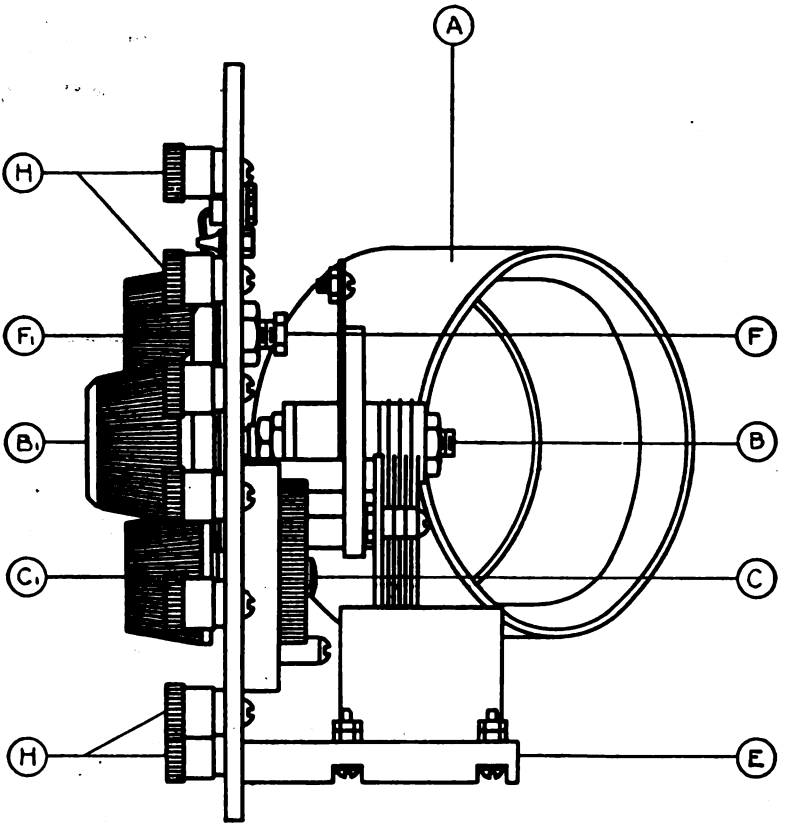

A SIDE VIEW OF THE SET—AS SEEN FROM THE RIGHT

FIGURE 5: *In this drawing is shown the method of mounting the coupler, the condenser, the rheostat, the socket and the binding posts. The knobs and dials are fastened to the shafts of the instruments (where they protrude through the face of the panel) by set-screws.*

The outline of this set is as simple as it has been possible to make it and for this reason the use of telephone jacks has been eliminated; the telephones are connected direct to the two top right-hand binding posts.

The size and general plan for making the cabinet are shown in Figure 6, and this may be constructed of hardwood by the prospective builder, or the diagram may be cut out of the article and given to a cabinet maker who will be able to make the cabinet from the instructions contained therein. Or, it may be purchased from many of the radio stores, as it is of standard size.

When the work of construction is at last complete, all that remains is to correctly wire the instruments.

How to wire the Set

Many people who take great pains with the mechanical appearance and construction of their apparatus, fall down miserably when it comes to wiring the set. This is unnecessary, as it takes little extra effort to wire a set neatly than it does to do it in a slipshod manner.

Number fourteen hard drawn tinned copper wire is recommended for this purpose or the square, tinned copper, bus-wire may be used if desired. "Spaghetti" (varnished cloth tubing) should only be used where necessary. A well designed set should need little of it. It is useful, however, for covering the leads from switch taps which are made with smaller wire. (No. 24 is suitable for this purpose.)

Small copper or brass lugs should be used on connections to binding posts, etc., and the connecting wires soldered firmly to these.

The method and general arrangement of the wiring can be easily followed in Figure 1. For those who cannot follow a regular diagram, Figure 2 should make it clear. The two posts marked "load" should be bridged (connected together) when receiving lower wavelengths. For longer waves a loading coil may be inserted between them.

The connections to lugs should be carefully soldered. Do not use acid as a flux, soldering paste may be used if care is taken not to use too much. Use very little and wipe it off again before applying the iron, otherwise it will

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spread over adjoining surfaces and cause corrosion and leakage in the set. The author uses "rosin core" solder almost exclusively rather than paste or acid. This is somewhat harder to handle, however, and the surfaces must be thoroughly cleaned before tinning. This solder used in conjunction with the paste is a satisfactory combination and quite easy to manipulate. Make the soldered joints neat. A small drop of solder, properly run over the joint, is just as effective and much neater in appearance than large gobs which disfigure the wiring.

Operating Data

After having connected batteries, phones, antenna and ground to their respective binding posts, insert the vacuum tube in its receptacle, making sure, however, that the rheostat is turned all the way to the left or "off" position.

Place the left hand or tickler dial A1, at O, and the condenser or tuning dial B1, at about 50. The switch knob, F1, should be placed on the tap which leads to the extreme end of the coil. Turn on filament current by rotating rheostat knob C1, until a slight hiss is heard in the phones, then turn back until hissing sound disappears. (This applies only to UV-200 or other "gas" tubes. For WD-11 or WD-12 tubes turn on rheostat until filament shows dull red.)

Rotate tuning dial B1, slowly until desired station is heard. The signal may then be made stronger by increasing tickler dial A1, gradually while at the same time retuning slightly with condenser B1. If this reduces the signal strength instead of increasing it, reverse connections to tickler or inside coil. The signal strength may be increased with the tickler up to the point where the set breaks into self-oscillation. This condition is recognized by the musical whistling note which is heard when the condenser B1, is moved slightly off tune. The set is in its most sensitive condition just before it begins to oscillate or, in other words, when it is regenerating at a maximum.

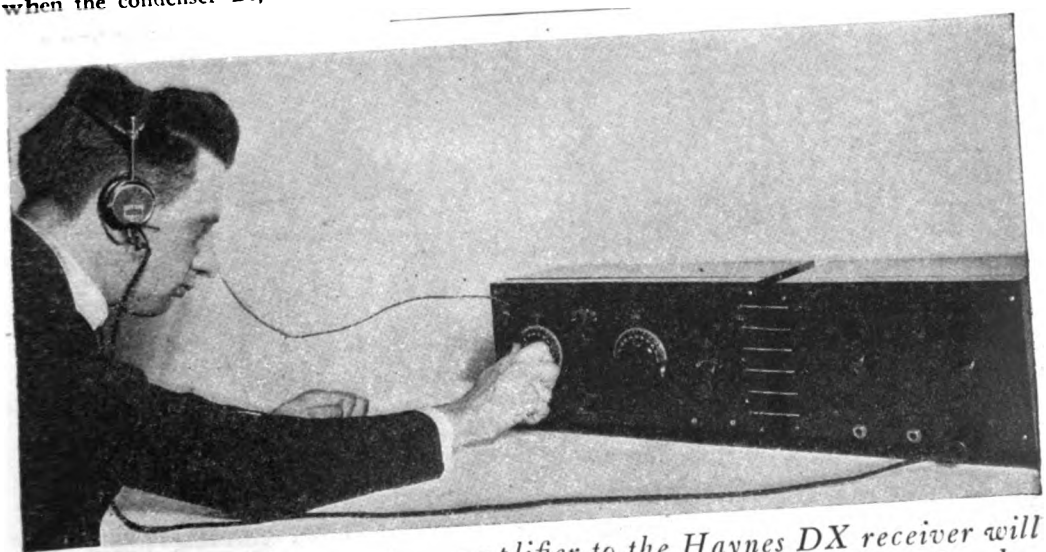
Loudest signal strength will usually be obtained when the primary switch F1, is set as indicated above, on the last tap, so as to include all ten turns on the primary circuit. However, if some undesired station is causing interference this switch should be moved back on one of the other taps and the set retuned. The further back this switch is moved or, in other words, the fewer turns of wire in the primary circuit, the sharper the set will tune.

The two binding posts marked "load" in Figures 1 and 2 can be omitted entirely unless it is desired to tune to wavelengths of over 550 meters.

The above instructions will give the novice a general idea of the operation of this set. After a few hours of operation he will become familiar with the tuning adjustments, enabling him to pick out the station he desires at will, and if his antenna and local conditions are at all favorable he should be able to do excellent long distance work.

As an example of what this set is capable of doing the following is an instance: In a New York suburb, just outside of the city, using a one wire antenna 35 feet high and 125 feet long, the following broadcasting stations were copied during one evening: Chicago, St. Louis, Louisville, Atlanta, Boston (WGI), Fort Worth, Texas, Minneapolis, and Havana, Cuba.

This was with a single tube set built by the author and operated by an average business man who knew little or nothing about radio theory. The set was identical with the one described herein and the operator had had less than one week's experience with it.



How to add a two-stage amplifier to the Haynes DX receiver will be described in the next issue of POPULAR RADIO—*for October*

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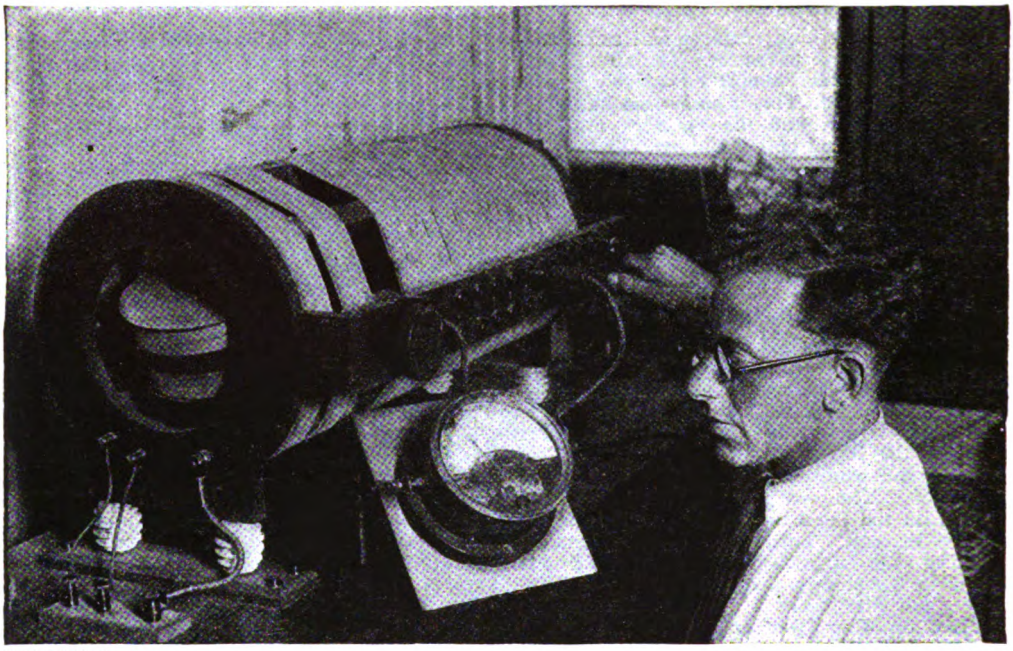

Kadel & Herbert

EXPERIMENTING WITH A COIL IN THE LABORATORY

To determine the correct sizes and shapes for the coils used in radio receiving sets has occupied the attention of scientists for years. Their work has included tests on small coils and large ones. This picture shows a large coupler which proved efficient—but only a bulky set could contain it.

HELPFUL FORMULAS FOR

DESIGNING YOUR COILS

The proper design for the coils used in both sending and receiving apparatus is one of the most vital points in radio engineering practice. Indeed, the inductance coil may be considered the backbone of radio. This important contribution on the subject was written for POPULAR RADIO by the foremost physicist of England—

SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

IN the first place, to keep the distributed capacity to a low value the actual wire used in coils for a receiving set should be thin, so as to expose but little surface. The wire should be of the highest conductivity, but the smaller its diameter the better, so far as this desideratum is concerned. Also the shorter the length the better, since the capacity varies directly with the length. The only disadvantage of a very fine wire is that its resistance is high. But, after all, resistance does not much matter. For a receiving station the current is feeble, and the thinnest wire will serve. It may be coated with silk, cotton or enameled. And if a stranded core is employed, the enameling of each separate strand is sufficient to keep them isolated from each other.

But it is well to wind the turns of wire not too close together. Hence a fairly thick cotton covering might be applied outside the real insulation, so

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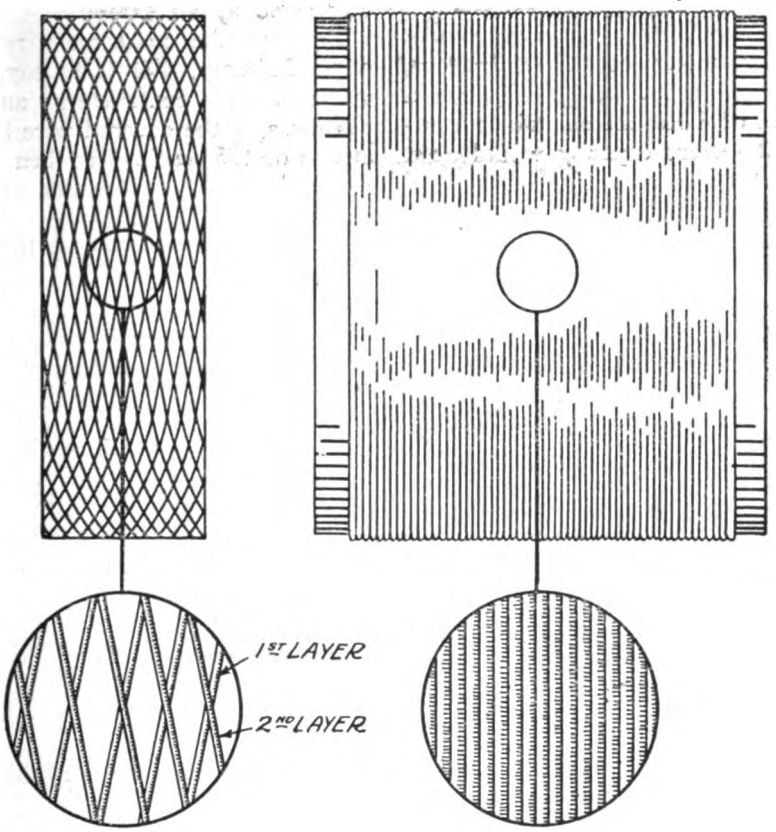
as to diminish the capacity effect of each turn upon the others. The thickness of the ultimately covered wire may therefore, be three or four, or even ten times the thickness of the copper core; but I doubt if it is ever necessary or advisable to use a covering as thick as that. And were it not for the practical experience which has developed "basket" or open winding, I should have been disposed to advocate a close compact coil, wound so as to give maximum inductance for a given length. In any case, maximum inductance must be aimed at, whether the covering of the wire be thick or thin. I shall assume then that the wire to be used has an external diameter or thickness T, and that the copper core has the thickness *t*, and shall proceed to consider what is to be done with it.

Given the antenna capacity and the wavelength or range of wavelengths desired, we can at once determine the inductance or range of inductances necessary. Here is the formula, which gives the coil inductance as the square of the wavelength divided by forty times



TWO STANDARD METHODS FOR WINDING COILS

The coil on the left is known by numerous names, such as basket weave, honeycomb and duolateral; the turns of wire cross each other at an angle and therefore, the capacity between turns (called the "distributed capacity" of a coil) or between layers is low. Compare this method of winding with the coil on the right, which is an ordinary solenoid winding. Here the turns of wire lie right along side of each other and close together; the distributed capacity of such a coil is high, especially if a number of layers are wound over each other.

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the antenna capacity; *everything being expressed in the same units of length**:

$$\text{Inductance} = \frac{\text{Square of wavelength}}{40 \text{ times the capacity}}$$

$$\text{that is } L = \frac{\lambda^2}{40C}$$

For instance, to receive on a wavelength of 200 meters with an antenna whose capacity is 1 meter, which would be a likely value for a single wire elevated by a pole 20 meters high, the coil must have an inductance,

$$L = \frac{40{,}000}{40} = 1{,}000 \text{ meters.}$$

that is, 1 kilometer, or 10^5 centimeters, or a tenth of a millihenry. To get a wavelength of 1,000 meters with an antenna of 2 meters capacity would need an inductance

$$L = \frac{10^6}{80} = 12{,}500 \text{ meters,}$$

that is, 12½ kilometers or 1¼ millihenry. Twice this value would be needed if the capacity of the antenna were halved. But if the wavelength were to be doubled the inductance must be quadrupled.

Now, to get the necessary inductance in a coil, using the smallest length of wire, we shall show in another chapter, what has already been stated, that it must be wound on a frame of the following shape and dimensions, *viz.*, a disc coil of external diameter 14 units, of internal diameter 8 units, and with the channel for the wire a square, 3 units to a side. There remains only to determine the size of the unit which will give the required inductance L, for wire of given external thickness T. The formula for determining the actual size of the coil's external diameter D, is:

$$D^5 = 66.6LT^4$$

And once having determined D, the size of the coil is known in every detail, also the number of turns of the given kind of wire, and the length of wire necessary.

The use of this formula will be best illustrated by an example.

Suppose the inductance required is one millihenry, that is to say, 10 kilometers or 10^6 centimeters; and let the thickness of the covered wire be 2 millimeters or 1/5 centimeter; then D^5, comes out from the above formula as

$$D^5 = \frac{66.6}{625} \times 10^6,$$

or a trifle more than 10^5; and therefore the extreme diameter D = 10 centimeters practically. The internal diameter *d* will then be

$$d = \frac{8}{14} D = 5.7 \text{ centimeters;}$$

the breadth of the coil b, or the side of the square channel in which the wire is wound will be,

$$b = \frac{3}{14} D = 2.142 \text{ centimeters;}$$

the number of turns n, of covered wire of thickness five turns to the centimeter will be

$$n = \left(\frac{b}{T}\right)^2 = 115;$$

the mean radius of a turn r, is,

$$r = \tfrac{1}{4}(D + d) = 4 \text{ centimeters;}$$

and hence the total length of wire is,

$$l = 2\pi nr = 27.6 \text{ meters.}$$

Or it may be more convenient to work with inches, so far as the workshop dimensions are concerned. If we are dealing with the same inductance

*See Appendix for explanation. The following table will effect conversion from conventional capacity units to length units: the latter being in many respects more convenient except for large capacities:

1 microfarad = 9 kilometers
1 millimicrofarad = 9 meters
1 micromicrofarad = .9 centimeter

For practical purposes a capacity expressed in micro-microfarads may be interpreted at once as nearly equal to the same number of centimeters. A ten per-cent allowance can be made if desired, for a centimeter is ten percent bigger than a micromicrofarad.

For *inductances* the conversion is still easier:

1 henry = 10,000 kilometers = a thousand million centimeters
1 millihenry = 10 kilometers = a million centimeters
1 microhenry = 10 meters = a thousand centimeters
1 millimicrohenry = 1 centimeter

Hence, to express inductances in centimeters is always quite easy.

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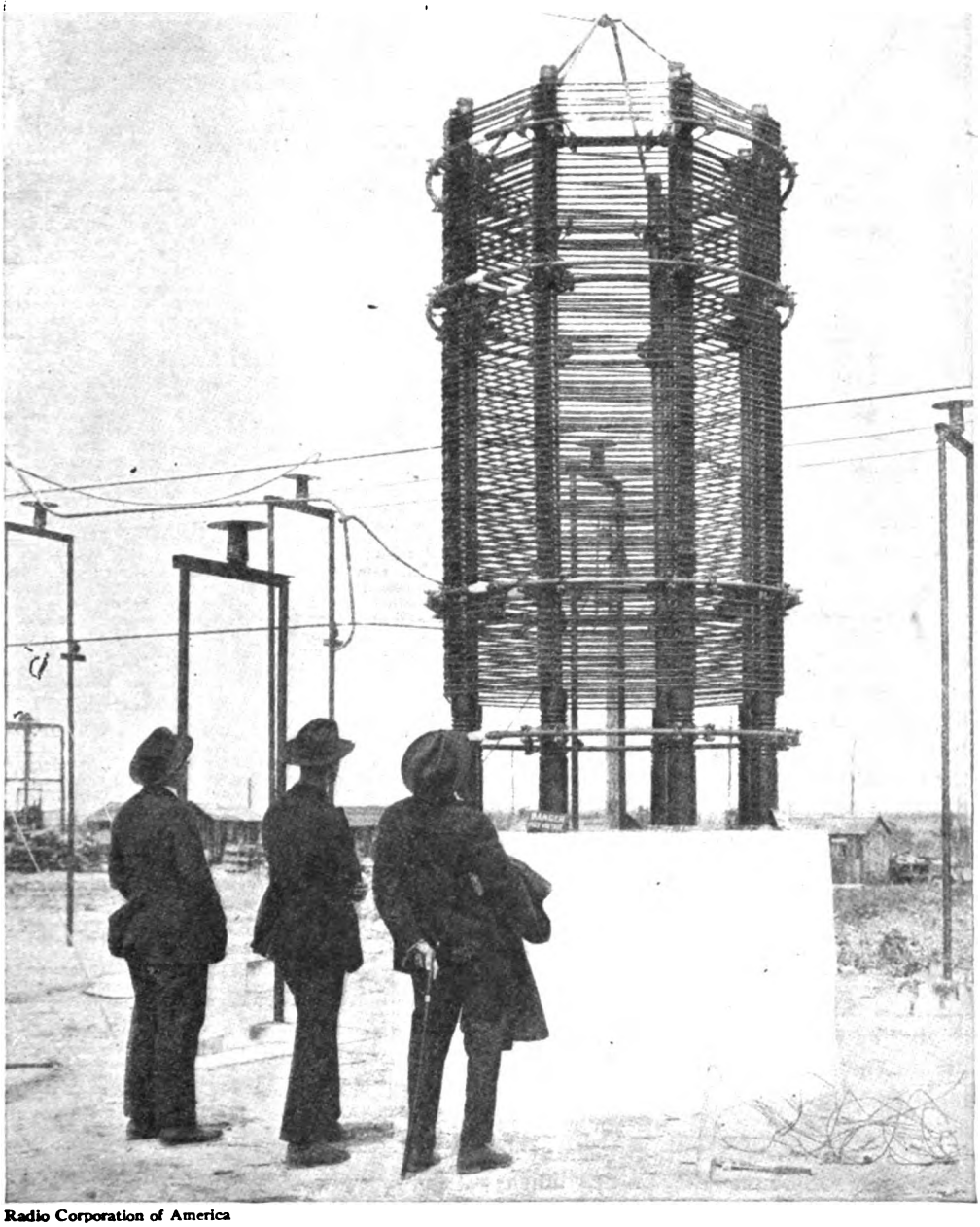

Radio Corporation of America

ONE OF THE BIGGEST COILS IN THE WORLD

Here is shown one of the great tuning inductances used at the large central radio station at Rocky-Point, Long Island. Compare the size of the coil with height of the men standing in the foreground. If this coil were not efficient there would be enormous losses in the power surging back and forth in the huge transmitting antenna. Although your coil is tiny, if it is not properly designed the losses in it may be just as large—relatively.

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we must divide 10^6 centimeters by 2.54 to bring it to inches. Or we may take as example a round number: Let the required inductance be L = 400,000 inches, while T, the thickness of the wire, = 1/10 inch. Then we can reckon the external diameter of the coil, in inches, as:

$$D = \sqrt[5]{\frac{66 \times 400{,}000}{10{,}000}} = 4.84 \text{ inches.}$$

So that the internal diameter will be d = 2.72 inches. And the side of the square channel b = 1.03 inch. The number of turns will be,

$$n = \left(\frac{b}{T}\right)^2 = 106,$$

and the length of the wire used,

$$l = \tfrac{1}{2}\pi\,(D + d) = 1{,}260 \text{ inches or 35 yards.}$$

The result we see is not a large coil, even for so thick a covered wire. By diminishing the thickness of the wire the coil can be much decreased in size. For if the size of the channel is given, then the use of a wire of half the thickness will give a 16-fold inductance, because it depends inversely on the fourth power of the thickness. This is indeed obvious. For if the wire is half as thick, double as many turns can be put in each layer, and there will be twice as many layers, so the number of turns altogether is quadrupled. And as the inductance depends on the square of the number of turns, that will be magnified 16 times.

As regards size of bobbins for a given thickness of wire, we can make this statement: doubling the linear dimensions of the bobbin for a given wire will magnify the inductance of the resulting coil 32 times. This is not quite so obvious, but it clearly appears from the formula, since L varies with the fifth power of D, and $2^5 = 32$. Meanwhile the question obtrudes itself: Where does the 66.6 come from?

That, however, is rather a long story, and must be the subject of another chapter.

APPENDIX

A PLEA FOR EASY SPECIFICATION

By Sir Oliver Lodge

When working with ordinary coils and condensers in the laboratory, the specification of capacity in microfarads is convenient enough, and so is the specification of inductance in terms of henries or secohms. But when working in radio wavelengths, it is convenient to have the antenna capacity, and the inductances associated with it, expressed in terms of length because the geometric mean of those two lengths—that is, the square root of their product—gives the wavelength direct when multiplied by 2π, that is practically for rough estimate, by 6. Six times the square root of the inductance and capacity multiplied together is a close approximation to the wavelength; and in predetermining the inductance required for any given case this must surely be a handy rule.

Capacity in electrostatic measure is a length, and inductance in electromagnetic measure is also a length. The truth is that in all units—that is to say, in absolute measure—capacity is really K times a length, while inductance is μ times a length. And it is natural to express the one in static measure, under the convention that $K = 1$, and the other in kinetic—that is, magnetic—measure, with the totally different convention that $\mu = 1$. For the one has to do with charge, and the other with current.

The capacity of an ordinary amateur antenna is some simple fraction of its height or linear dimensions: about one-twentieth of the length of an isolated thin single wire measures its capacity. But the fraction may vary for different antennas from a twentieth to about a twelfth, as will be shown later. A microfarad is far too big a unit for convenience. A millimicrofarad, or even a micromicrofarad, has to be employed, and they are by no means convenient. The length corresponding to a microfarad is 9 kilometers. So a millimicrofarad is 9 meters, and a micromicrofarad is nine-tenths of a centimeter; that is to say, 10 micromicrofarads equals 9 centimeters. So that for a rough estimate it may be taken as a centimeter, though it is a trifle smaller.

On the other hand, a henry is 10,000 kilometers. So a millimicrohenry—or what is sometimes called a billihenry—is exactly 1 centimeter. While a microhenry is 10 meters, and a millihenry 10 kilometers.

Conversion from one set of units to another is always a nuisance. But after all a henry and its sub-multiples have no particular meaning which the imagination can seize hold of; whereas the length of a meter or a kilometer is easily imagined. Hence it might be well to have the coils used in radio thus marked—that is, marked in terms of length—using any unit of length that is handy for the purpose and suitable to the coil. Thus, take an antenna with a capacity of 1 meter, and put a coil of 10,000 meters inductance in series with it. The geometric mean of the two is 100 meters, and the wavelength, therefore, 600 meters.

The meter as a rule is the most convenient unit of length under the circumstances, since wavelengths are commonly so specified. But some people prefer to work in centimeters; and it is easy enough to remember that a billihenry is 1 centimeter. The farad is not a convenient unit. It was always much too big; but it can be remembered that a microfarad is equivalent to a length of 9 kilometers. In radio work, however, it is certainly more convenient to express capacity as a length, whether it be agreed to specify inductance also in that way, or not.

It is curious to note that a farad coupled to a henry would have a slow oscillation period of six seconds; and so give a quite inappreciable wave, 1,800,000 kilometers long. A microfarad connected to a henry of inductance would oscillate a thousand times in six seconds, and so generate a wave 1,800 kilometers long. Whereas a microfarad coupled to a microhenry would have a frequency a thousand times as great, and so might give a strong wave 1,800 meters in length; the same wave being also generated by a millimicrofarad coupled to a millihenry; which may be expressed as a 9-meter capacity and a 10,000-meter inductance.

The intensity of radiation increases very fast as the wave is shortened.

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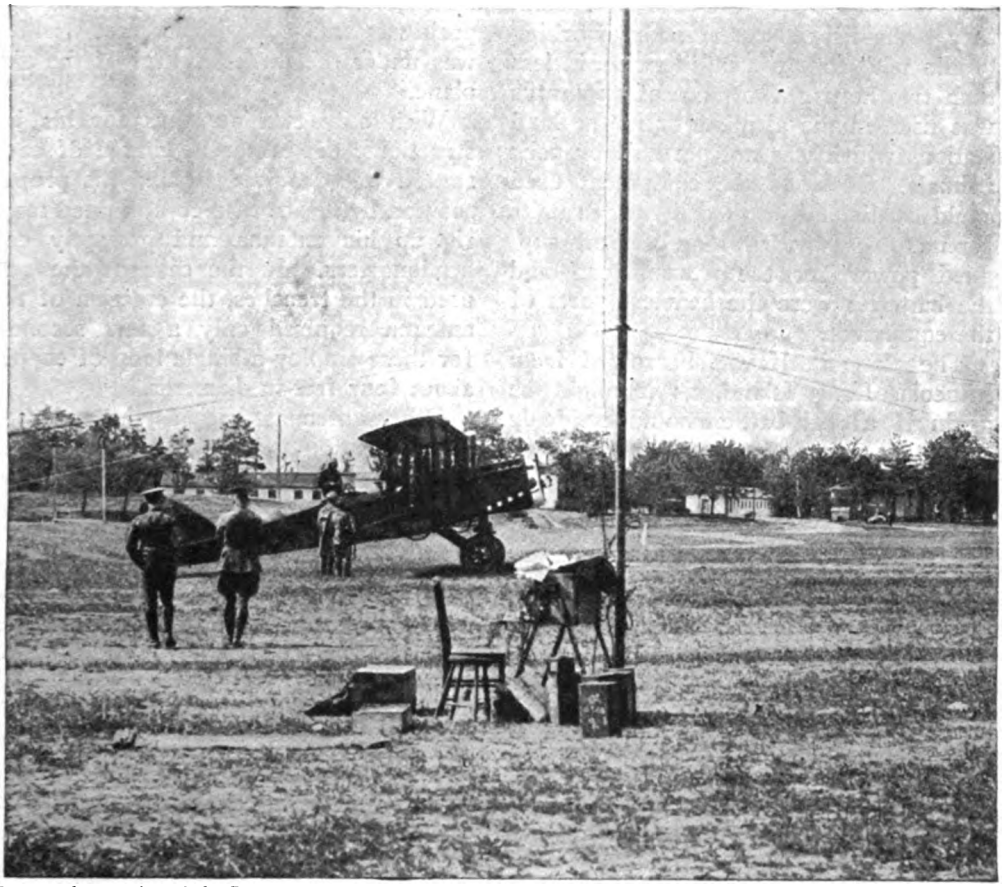

From a photograph made for POPULAR RADIO

THE ARMY'S PORTABLE GROUND STATION

Storage batteries are used for power, and the antenna system is supported by a collapsible mast that may be erected in sections in a few minutes. This mast also forms the support for the umbrella counterpoise that is shown above.

A "Radio Net" Controlled from the Sky

How the operations of an army may now be directed by portable radio equipment operating in co-operation between ground stations and airplanes in flight.

By PAUL McGINNIS

AIRPLANE communication that requires only an ordinary field radio set is now considered practical as a result of tests made in a "radio battle" at Camp Alfred Vail, New Jersey.

Observations made over theoretical front-line trenches about seven miles long were reported with accuracy, and orders were received from the ground through a radio set which was hastily rigged on the airplane under conditions that prevail in a sudden war emergency.

The test was made in the final maneuvers of fifty-eight officers who recently graduated from the Camp Vail Signal School, after nine months of training under Signal Corps instructors. Starting at camp in the early morning,

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they established a smooth working "radio net" for an army division in less than two hours. No piece of apparatus was used in the airplane or in the land stations which was not portable by pack animals. Most of the equipment used could be divided into small enough units for men to carry. Storage batteries supplied power for the transmitters—and the batteries were the heaviest parts of the equipment.

The plane itself was borrowed from Mineola, Long Island, as it might be again if a real battle should suddenly take the place of the shadowy ether battle which went on with such smoothness. A transmitting set in which the handy "five-watters" of amateur fame, the little transmitting vacuum tubes which have often before handled big business, were used in the set which was mounted so hastily in the rear cockpit.

The plane's antenna was a single wire which was let down with a weight attached to the end, after the plane had cleared the ground, and drawn up before descending. The ground connection was fastened to the metal part of the engine and the frame of the machine, which formed a counterpoise. Phones equipped with rubber caps were placed inside the aviator's helmet, thus shielding his ears from the engine's noise.

The country in which the tactical battle was fought was typical woodland, with roads and paths crossing and recrossing and going nowhere in particular, and it was under such conditions that the various station units found their positions and spread the "net" which was under the direct control of the airplane.

With only two numbers for his instructions, the officer in charge of each station was required to find his proper position by means of a co-ordinated map, rig up his antenna and promptly call headquarters. In the case of the sets used in the trenches, the erection of the antenna required only a few seconds, for these employ a single loop of copper about four feet in diameter.

Other antennas, such as the one used by the station in immediate touch with the airplane, were strung from poles erected in sections and held in place by guy wires.

Interference, between the various stations of the net, was avoided by the use of vacuum tube transmitters throughout, which were sharply tuned.

A number of messages similar to those which are actually transmitted in battle were given to the various stations to send, and information from the airplane was received and relayed to headquarters with war-time precision. The plane could be heard for a number of miles outside the net as it flew over the "enemy's" country.

Transmission from airplanes both by telephone and telegraph was perfected toward the end of the World War, but the feat of placing an ordinary field set on an ordinary machine with practical results was almost unthinkable. Developments which made this latest test possible are *better tubes for transmitting* and *more sensitive receivers.*

How to Make a Simple Honeycomb Set

ANOTHER *valuable article of the famous "How to Build" series will be published in the coming—October—number of* POPULAR RADIO. *The total cost of the parts does not exceed $15.00. This set, like every set described in these articles, was actually built and tested and put into actual operation before the article was written. Ask your newsdealer to reserve your October copy now.*

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

New Regulations Concerning Amateur Licenses

THE Department of Commerce has authorized a broader band of wavelengths for general and restricted amateur radio stations, and has created a new class of amateur operator's license to be known as Amateur Extra First Class.

The new regulations provide that:

Licenses will be issued permitting the use of any type of transmitter (CW, spark, AC-CW, ICW, unfiltered CW and phone) with the restriction that when using pure CW they are authorized to use wavelengths from 150 to 200 meters and when using spark, AC-CW, ICW, unfiltered CW and phone the wavelengths from 176 to 200 meters only can be used. The types of transmitters must be specified in the application and the license.

Special Amateur Radio Station licenses will be issued permitting the use of pure continuous wave transmitters only, authorizing the use of wavelengths from 150 to 220 meters.

For the purpose of application to amateur stations, pure CW is defined as follows: A system of telegraphing by continuous oscillations in which the power supply is substantially direct current as obtained from (1) a generator, (2) a battery, or (3) a rectifier with an adequate filter. (A filter is not deemed adequate if the supply modulation exceeds five percent.)

General Restricted and Special Amateur Stations are not permitted to use a transformer input exceeding one kilowatt, or equivalent of this power based upon watt input to plates if tubes are used. (Where input rating of tube is not specified by manufacturer this rating will be considered as double the manufacturer's output rating.)

On licenses issued for amateur stations you will include the following: *This station is not licensed to transmit between the hours of 8.00 and 10.30* P.M., *local standard time, nor Sunday mornings during local church services.*

Special Amateur Stations must be operated by persons holding an extra first grade amateur operator's license, or a commercial first class operator's license, or a commercial extra first class operator's license. Applicants must also meet the requirements of Regulations 63.

A new class of amateur operator's license is hereby established to be known as "Amateur Extra First Grade." Licenses of this grade will be issued to persons passing the required special examination with percentage of at least seventy-five and code speed in sending and receiving of at least twenty words a minute, five characters to the word; who have had at least two years' experience as a licensed radio operator and who have not been penalized for violation of the radio laws subsequent to the date of these regulations.

* * *

A Useful Battery Cut-off

ONE of the greatest routine nuisances of a radio set is the necessity for turning rheostats on and off. This is an especially burdensome task in the case of some of the recent vernier rheostats which require several revolutions of the knob to bring the tube up to proper operating temperature. How this trouble may be overcome is described below:

Use special jacks that control the filament circuit, so that by the simple process of inserting the phone plug one not only connects the phones into the circuit, but also lights the tube. This is probably the ideal arrangement because it lights only the tubes that are being used. In other words, if the phones are plugged in the first jack only the detector tube will light; while two tubes are lighted if the plug is inserted in the second jack, and so on.

The one drawback to this plan, however, is

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that the wiring up of these jacks is a complicated proceeding at best and in the case of a set that is already built, it means removing the present jacks, replacing them with the special jacks, and rewiring the whole thing.

I have found that I got practically the same results by a simpler process. I have simply installed an ordinary push-button battery switch at a convenient point on the panel of my set so that by pulling the button out the "A" battery circuit is closed, thus lighting the tubes. When I finish listening in I merely push the button to turn off all the tubes. Turning the filaments off in this way also cuts off the "B" battery, of course, as current will not flow in the plate circuit unless the filament is lighted. Thus the rheostats are left turned on at all times but can be adjusted as needed for critical tuning. To listen in on the detector alone the other tubes may be turned off by means of the rheostats or, a switch may be installed in one of the filament leads of each amplifier tube. For ordinary use, however, one switch controlling the entire "A" battery circuit is sufficient.

Such an arrangement is especially useful in a household where the family make use of the set during the day. The set can be left all tuned for a certain station and whenever that station is operating it will only be necessary to pull the button to listen in. Thus the family can enjoy the set in the absence of the owner, without the necessity of tuning in and without the danger of turning the rheostats too high with the possible chance of burning out a perfectly good tube.

Push button battery switches may be obtained with a red button and this button is the only part that appears on the front of the panel. The part behind the panel is about one inch in diameter and a half inch in thickness.

S. GORDON TAYLOR

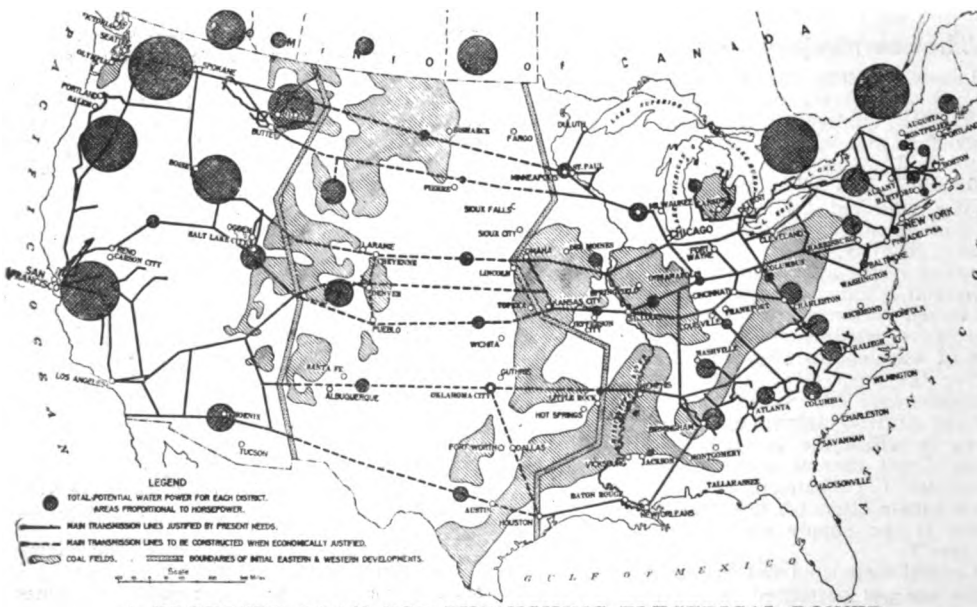
* * *

How to Test Your Headphones With a Tin Can

IN the May issue of POPULAR RADIO, was published a description of how to make a testing battery for your headphones for eleven cents. Here is a suggestion that comes to us from a fan in Oregon, who tells how to make one that is just eleven cents cheaper:

Take an ordinary tin can, or place your hand on any piece of zinc. Take one tip of your headphone cord and hold in the fingers of your other hand. Let the free tip drag across the tin can or piece of zinc. If a faint scratching sound results your phones are in good order.

O. E. SMITH


LEGEND
TOTAL POTENTIAL WATER POWER FOR EACH DISTRICT. AREAS PROPORTIONAL TO HORSEPOWER.
MAIN TRANSMISSION LINES JUSTIFIED BY PRESENT NEEDS.
MAIN TRANSMISSION LINES TO BE CONSTRUCTED WHEN ECONOMICALLY JUSTIFIED.
COAL FIELDS.
BOUNDARIES OF INITIAL EASTERN & WESTERN DEVELOPMENTS.
GULF OF MEXICO

A PROPOSED PLAN FOR FURNISHING ELECTRICAL POWER TO THE ENTIRE UNITED STATES

Electric power development is of direct interest to the radio fan, not only because radio uses power but also because of the occasional interference by leakage from high-tension lines. This map—the last word in American power distribution—shows how Mr. Frank G. Baum, well known electrical engineer of San Francisco, proposes to unite all the power plants of the country into one great super-power system. General Guy E. Tripp says of this plan: "The single system is not only practical and desirable, but, in my opinion, essential to American progress."

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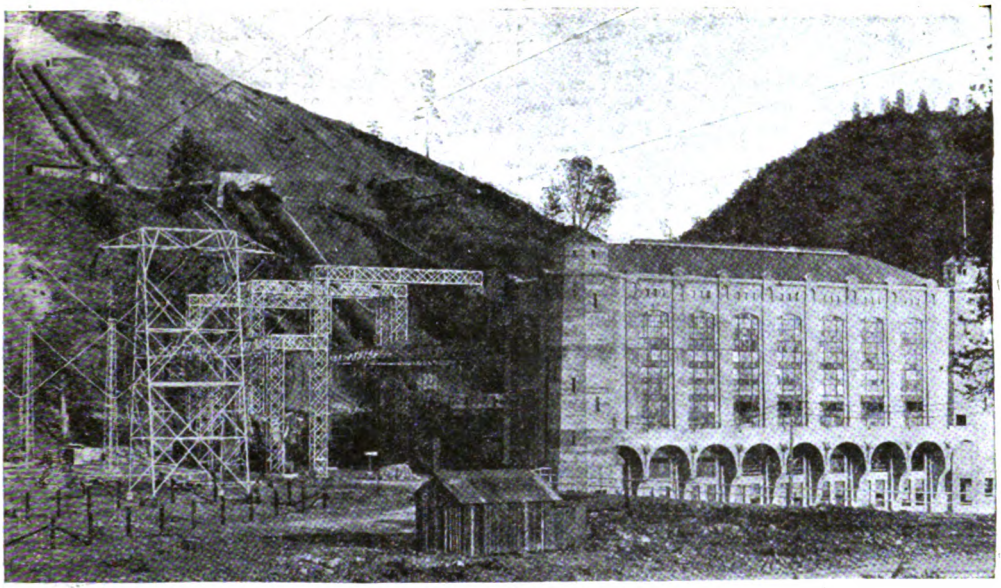


WHERE MEN TALK
OVER HIGH TENSION CABLES

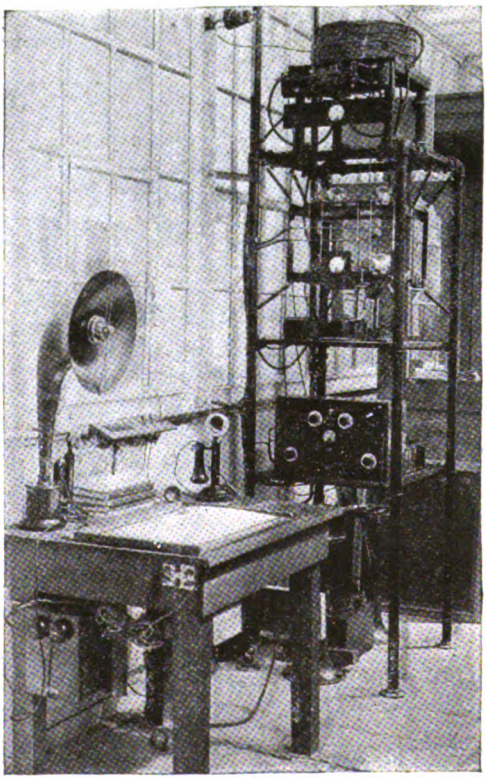
A unique application of "wired wireless." Below are some of the instruments that are used. The voice is relayed from the telephone to the radio transmitter by means of the loudspeaker which is connected to the telephone line and the microphone (at its mouth) which is connected to the transmitter.

The Longest Guided Radio System in the World

WHAT is probably the longest system of guided radio in the world has recently been put into successful operation along a power line in California. Messages have been transmitted from a sub-station at Vacaville to the Pitt River power house 202 miles away.

The radio waves are transmitted along a 220,000-volt power line of the Pacific Gas and Power Company. They follow the course of the steel towers across country 120 miles in a straight line due north from Vaca-Dixon to Cottonwood; then they make a right angle turn and run for 82 miles to their destination.

Under this system of guided radio (or "wired wireless" as it is often called) the energy is not broadcast but is kept close to the high-power transmission lines. Consequently it does not interfere with normal reception except in the case of stations which are located in the immediate vicinity of the line.



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These Balloonists Saw Lightning but Recorded No Static

One of the unexpected results of the National Balloon race was the report of one of the contestants who carried a radio set for the purpose of receiving weather signals. While the aeronauts watched thunderstorms below them no static effected their receiving apparatus.

Does Static Disappear in the Higher Altitudes?

STATIC, that mysterious interference to the reception of radio signals which is perhaps one of the greatest puzzles to radio experts today, may be confined to an atmospheric belt about the earth. At least that is the possible conclusion reached in special tests made by Ralph Upson, one of the country's most prominent aircraft engineers who was a contestant in the National Balloon race which started from Indianapolis on July 4.

Upson's chief purpose of carrying radio was to help him win the race. Five of the principal broadcast stations had arranged to send out special weather reports on upper air currents during the first night of the race and the following morning. In addition to Upson, the three army entries in the national race were equipped with similar sets. Lieut. Olmsted, one of this trio, won the race. Here is the tentative report of Upson's observations of the unusual immunity of his apparatus, made after the race:

"One of the outstanding happenings in the use of radio in the balloon race was that at altitudes of 3,000 feet and above we observed absolutely no static whatever, although we could see lightning at various points on the horizon.

"Andrus, my aide, acted as chief radio operator. He began listening in at 8.30 o'clock the night of the race. At first he could hear nothing but code signals, concerts from various stations and a radio drama that was being sent out from a Chicago station. For an hour, this was about all we could hear. Then at 9.45 o'clock, Central Standard time, Andrus picked up the latter part of the weather report being broadcast from WGY in Schenectady. We heard just enough of it to make us wish we had heard the entire report. However, our disappointment was short for a few moments later the whole report was repeated, every word being received clear and distinct. It was just the news we wanted.

"As a result of the information, we decided to go a little higher but not to try any high altitudes unless forced to it by thunderstorms. The report gave us full confidence of reaching New York state and possibly New England. Everything seemed so favorable that I turned in to sleep, leaving the balloon appendix partially closed. Then came the accident and you know the rest—a forced landing."

—RALPH UPSON

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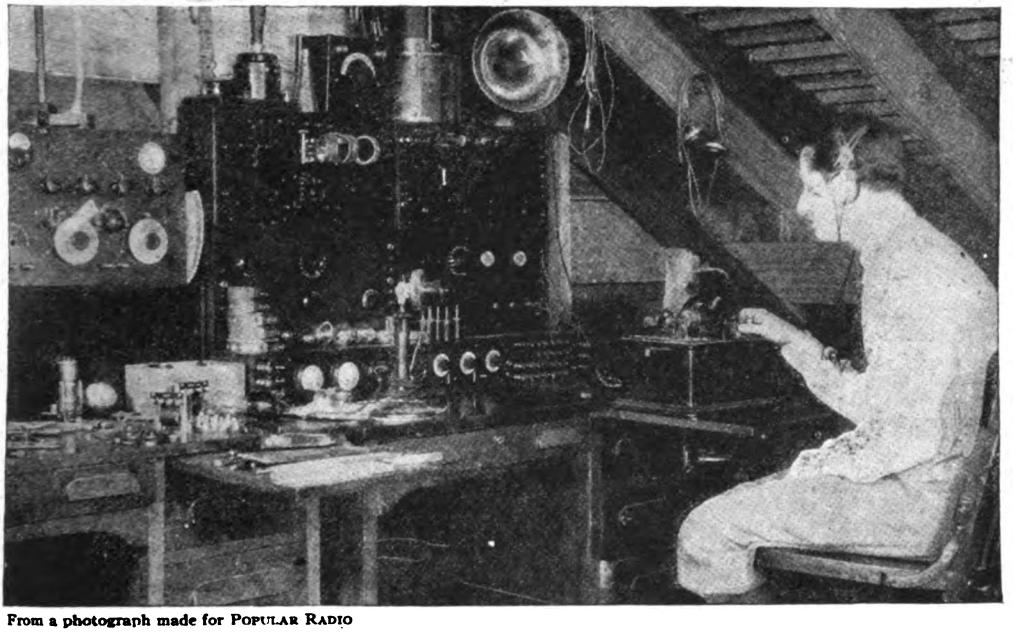

From a photograph made for POPULAR RADIO

HOW ONE AMATEUR MAKES A PERMANENT RECORD OF A FAVORITE PROGRAM

With the aid of a phonograph, Mr. R. W. Gates has succeeded in making remarkably good wax records of both music and speech broadcast from a nearby station. How he does it is described below.

Transcribing a Broadcast Program on a Gramophone Record

HERE is a novel idea that comes from a radio fan in Plainfield, N. J. Just what the legal aspects of his experiment may be, however, is a point for a lawyer to determine.

When a worth while program is being broadcast have you ever wished there was some way of keeping it to be repeated at your pleasure?

I have—and started to work on the idea. I took an old Edison phonograph that was driven by an electric motor and tried some recording, using my regular three-tube radio set, a Baldwin phone which I connected direct to the recorder and some old brown wax records (which I found in the attic) of the vintage of '96. My first trouble to overcome was the sparking of the motor which recorded much interference, so I discarded this apparatus for an old spring machine which was O. K.

Next, in order to get quality, I built up a five-tube set (two radio and two audio) which recorded almost perfectly except for volume, which at times was so great that it would knock the stylus all over the record. To overcome this I made a special chamber containing a butterfly valve, similar to a damper in a stove pipe, inserting it between the recorder and the phone; in this way I got perfect control of my last trouble, so that at present I am able to make records as perfect as any you might buy, with limitations only to the range of my receiving set.

R. W. GATES

* * *

A Practical Pointer on Varnishing Your Cabinet

HERE is a useful tip from an amateur who writes from practical experience:

Glued joints between wood surfaces that have first received a coating of shellac or varnish have a comparatively low or erratic strength. Government tests have proven this. For this reason the parts of the radio cabinet should, if possible, be glued first and shellaced or varnished afterward.

If the parts have been shellaced first, all joints should be carefully and thoroughly cleaned before application of the glue in order to make a strong joint that will be reasonably permanent.

Observation of this simple but valuable pointer will avoid possible joint separation for which a perfectly good glue or poor workmanship may be blamed.

ED. HENRY

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Why We Cannot Send so Well by Day

SIR Oliver Lodge's article on the Heaviside Layer theory (in the January, 1923, issue) called forth this comment from a reader, who modestly explained that "when professors disagree, the student may be pardoned for expressing an opinion":

Sir Oliver Lodge takes the stand that without the Heaviside Layer theory it would be impossible, or at least difficult, to explain the deleterious effect of sunlight upon radio transmission. Furthermore, the existence of a Heaviside Layer seems to be a well substantiated fact.

But the mere existence of a Heaviside Layer does not prove that it bends, confines, reflects, or otherwise guides the radio waves.

No doubt Sir Oliver is right when he states that such a layer would be more or less distorted by the vertical currents which are caused by the midday heat of the sun. Even granting this, however, it is not necessary to conclude that this distortion is the cause of the poorer transmission by day. This poorer transmission is known to exist, but there may be some other explanation for it; in the opinion of the writer there is. And that explanation can be summed up in the one word *interference.*

As the sun's rays and radio waves are both fundamentally the same — electromagnetic waves or disturbances in the ether—in all particulars except in length and in frequency, it seems evident that they could not both travel over the same route at the same time without interference.

Let us examine a case.

Suppose it to be early morning. Radio station A, is sending to another radio station B, which is due west of it. The sun's rays and the radio waves, therefore, are traveling in the same direction. The radio waves are oscillating at a rate of several hundred thousand times a second and the sun's rays at a frequency that is infinitely higher, but both kinds of waves are moving at the same speed. Some of the time, therefore, the alternations are in the same direction and some of the time they are opposed. When they are in the same direction, the oscillations from the sun's rays cannot assist those from the radio station as their speed is the same, but when they are in opposition they can offer an impedance which reduces the amplitude of the radio waves.

A crude analogy may help to make this clear. If you are walking westward in a narrow street with a crowd of people and another crowd is going eastward in the same street, the people going in the same direction as yourself will not be of any assistance to you in reaching your destination, but those going against you will interfere with your progress.

If this hypothesis is correct, radio communication should be at its worst in the case I have named. We have it on the authority of Marconi that transmission is at its worst "when the line of the sunrise or sunset is between the two stations."

But to say that the "twilight line acts as either a reflector or an absorber of the radio waves" is not enlightening, and to claim that the partial ionization of the sunlight of the air near the earth which increases the air's conductivity "decreases the efficiency of transmission" is not clear or explicit enough to be convincing.

GAY PRENTICE BLESSING

Keystone View Co.

A MACHINE THAT TAKES DOWN PHONE MESSAGES

This combination of telephone and dictaphone makes a record of incoming messages and repeats them in their original form. The device is applicable to radio.

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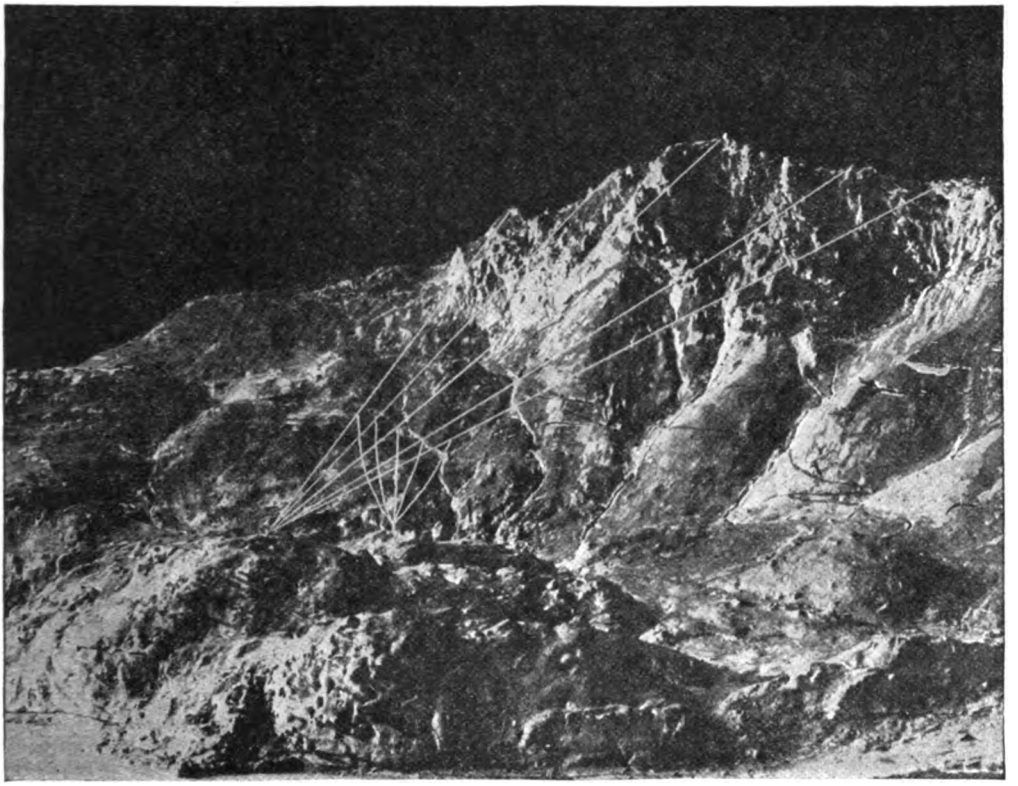

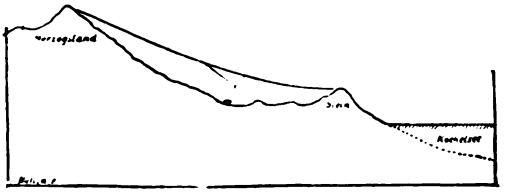

A RADIO STATION THAT USES A MOUNTAIN AS AN AERIAL TOWER

At this great transmitting station at Kochel in the Bavarian Alps, the antenna wires are stretched between two mountain peaks which are 1,732 and 904 meters in height, respectively. The small sketch shows how the lead-in is taken off in the center of the antenna and brought down to the operating building which is located in the hollow between the two peaks. The height of the mountain antenna is several times greater than the antenna on the Eiffel tower in Paris. The picture at the right shows Dr. Otto Scheller, one of the foremost radio experts of Germany and the chief engineer of the famous Lorenz Company.

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WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

¶ *In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry.*

QUESTION: Is it possible to use a microphone held up in front of a regular radio headset, so that the sounds from the headset will enter the microphone and thus amplify signals from a crystal receiver without the use of vacuum tubes? I do not know much about radio, but I have worked on telephone installation work for some time, and this scheme seems to present some possibilities.

JOHN E. WATKINS

ANSWER: This scheme will work on signals of fair strength if the microphone is connected in series with a suitable battery and a low resistance telephone. But there will be quite a degree of distortion in the output of the telephone on account of the acoustical difficulties between the diaphragm of the radio headset and the diaphragm of the microphone itself. In the long run it is much better to use a vacuum tube amplifier, as the former mentioned method never does give clear speech or music that would be really worth while listening to.

QUESTION: Is there any make of dry-cell tube that can be put into my present set, which employs the regular 6-volt tubes, without using an adapter or without having to change the sockets?

AUSTIN SERGEI

ANSWER: You may use the WD-12 in your set without making any changes except that you should use three dry-cells, connected in parallel, instead of the regular storage cells for your "A" battery.

* * *

QUESTION: Will you please give me a hook-up showing how to connect two stages of radio frequency amplification, a crystal detector, and two stages of audio frequency amplification to a variocoupler.

CHAS. G. ADAMS

ANSWER: You will find the circuit you require in Figure 4 on pages 396 and 397 of the May issue of POPULAR RADIO.

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QUESTION: Is it possible to use the four-circuit tuner with only one tube? If so will you kindly give me the proper circuit diagram showing how to connect up the instruments with a WD-12 dry-cell tube. I would also like to obtain a list of the parts necessary to use (with their constants).

H. G. BRADY

ANSWER: The circuit is drawn for you in Figure 1. The coils A, B, C and D, were fully described in the May, 1923, issue of POPULAR RADIO. The other parts you will need are the following:

E—vernier variable condenser, .0005 mfd.;
F—vernier variable condenser, .0005 mfd.;
G—mica fixed condenser, .00025 mfd.;
I—grid leak, 1 or 2 megohms;
C1—mica fixed condenser, .00025 to .00075 mfd.;
L—6 ohm rheostat;
Q—switch lever;
S—7 switch points;
Y—WD-12 dry-cell tube.

The capacity of the condenser C1, will have to be determined by experiment but it will be found to be within the two values given in the list. This is because the impedance values of the different makes of telephones vary so widely and this value is critical. A value should be chosen that will allow the circuit to oscillate just enough so that the condenser E, in the stabilizer circuit will have the proper control. If the condenser C1, is too large the circuit will not oscillate and if it is too small it will oscillate too much. It would be easiest to get three sizes, a .00025, a .0005, and a .00075 mfd. (the last may be made up of the first two in parallel) and try each one until the best results are obtained. Then leave the correct one in the circuit.

* * *

QUESTION: Why is it that some of the tubes on the market are all dirty inside of the glass? I have seen some of them that are yellowish and some that are brown or purple, and still some others that have a color something like oxidized silver. I asked a salesman in a radio store, and he told me that this discoloration didn't make any difference; in fact he said that the tubes that had it were often better than the clear tubes. Is this so?

R. ENSIGN

ANSWER: The new tubes usually are pumped to a very high degree of vacuum and at the time of evacuation there is injected into them a substance that helps make the vacuum still higher if the tube elements are heated at the same time. The various manufacturers use different substances for this purpose and this is the reason that the tubes sometimes have a deposit of one color and sometimes of another color. The tubes that are prepared by this method are usually superior to the old clear tubes, for amplification purposes, because they contain a higher vacuum and can be used with higher plate voltages and, therefore, produce greater plate currents and louder signals.

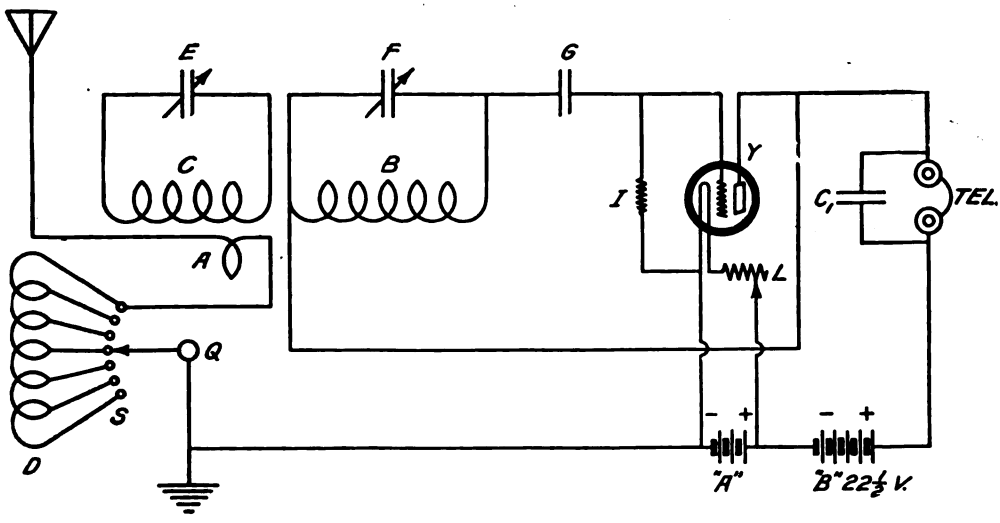

FIGURE 1

The four-circuit wiring diagram for use with a dry-cell tube receiver. The whole set may be made at a minimum expense and will give good results if good parts are used and the wiring job is done correctly.

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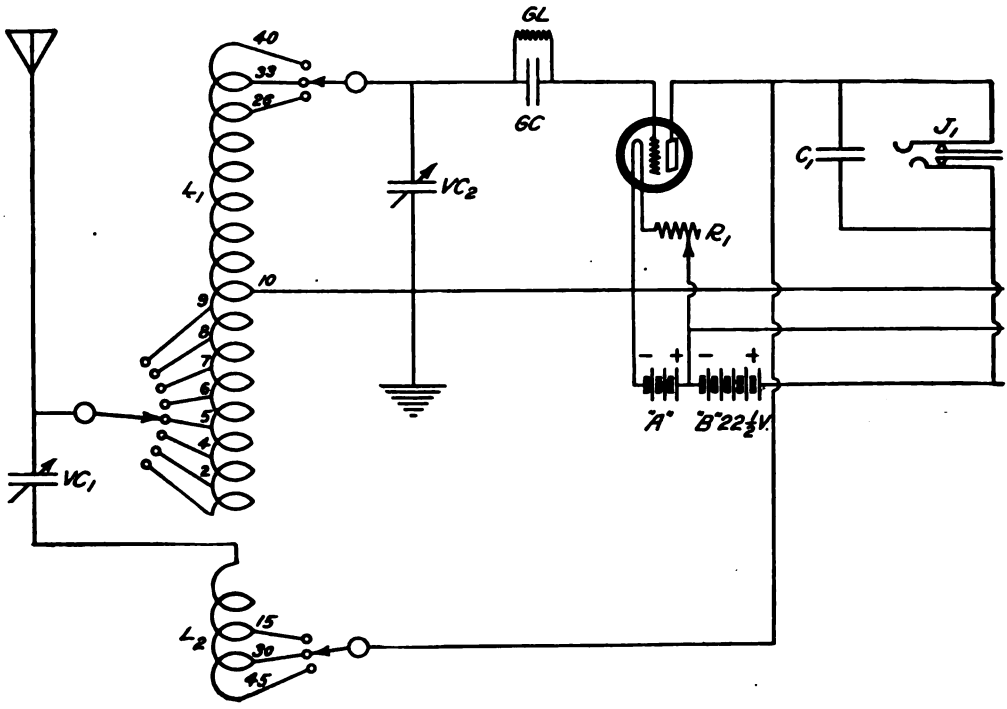

QUESTION: I have built and have been using the Reinartz circuit, as given on page 296 of the April, 1923, issue of POPULAR RADIO, with great success. I have received broadcasting from all over the country on a single tube. Now, however, I feel that I have outgrown the single tube class and would like to try my hand at loudspeaker reception. I therefore would like to have you send me, or publish in your magazine, the complete Reinartz circuit with two stages of audio frequency amplification, using jacks for the detector, for the 1st stage and for the 2nd stage of amplification, so that I can use the telephones or the loudspeaker at will.

H. F. ANDERSON

ANSWER: You will find the circuit in the diagram of Figure 2. The parts used in your former set may be left just as they were and the following parts added:

C1—mica fixed condenser, .0005 mfd.;
J1 and J2—double-circuit jacks;
J3—single-circuit jack;
AFT1 and AFT2—audio frequency amplifying transformers;
R2 and R3—filament rheostats;
Additional "B" batteries.

The values for the filament rheostats will depend upon the type of tubes used. Ask the dealer what resistance to use with the tubes when you buy them.

* * *

QUESTION: Why is it that I am able to tune in the local stations loud and clear, but have a great deal of difficulty in getting even fairly distant stations without a lot of squealing and howling? I am using a standard regenerative receiver (I am told it is) with one variocoupler and two variometers, and it takes me sometimes ten to fifteen minutes to tune in distance and sometimes they quit before I am able to get their call. Is there any way to overcome this trouble or at least partly eliminate it so that I can tune more rapidly? I find that when I get them almost tuned in if I reduce the detector rheostat just a little bit (it is very critical) they come in clear, but if I reduce it just a little bit too much the signals go out also. I am using a

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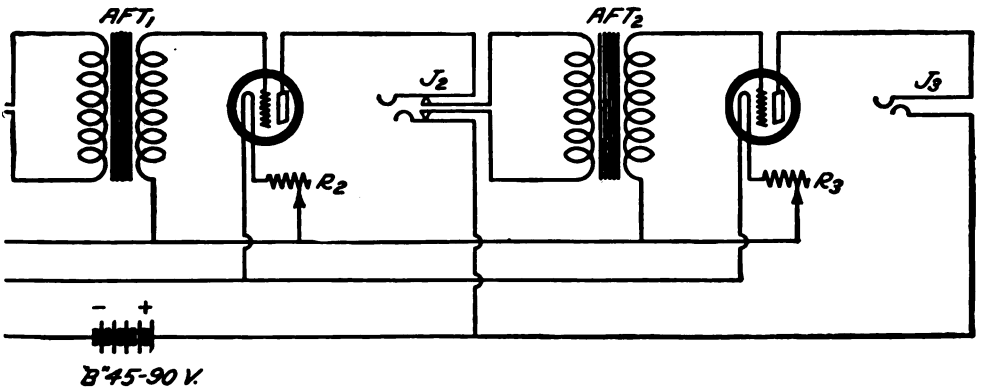
FIGURE 2

This hook-up shows how to add two stages of audio frequency amplification to the Reinartz tuner. The transformer AFT1, should be of a high ratio.



UV-200 tube for the detector, with 22½ volts on the plate.

EVERETT THOMAS

* * *

ANSWER: It would eliminate a lot of the unwelcome oscillation in your set if you reduce the plate potential of the detector tube (say) between 16½ and 18 volts. The reason that you notice the trouble on distant signals and not on local signals is that the local signals are *stronger* than the self-oscillations but the distant signals are distorted because they are *weaker*, and, therefore, partially drowned out by the self-oscillation of the detector tube. By reducing the plate voltage as recommended you will be able to cut out oscillation and thus control regeneration to a much finer point with the plate variometer. This should eliminate your trouble.

* * *

QUESTION: What is the usual length of wire used in the flat horizontal span of a single-wire antenna for listening to broadcasting?

E. SPANGLER

ANSWER: The usual length is between 100 and 150 feet, not including the lead-in.

* * *

QUESTION: Must I use mica condensers in a five-watt transmitting set, or will paper condensers serve as well? I am going to use only 350 volts on the plate of the tube with the Colpitts circuit.

S. D. JONES

ANSWER: Mica condensers should be used. They should be tested to withstand a voltage of 1,000 to 2,000 volts.

QUESTION: I am using the Hoffman charts for designing the coils for my receiving sets and find they work out very satisfactorily. Now, I want to design coils for a new set that I contemplate building especially for broadcasting. Will you kindly tell me the wavelengths between which the new coils should operate to take in the total band upon which broadcasting is being done at the present time?

ERNEST N. WITHERS

ANSWER: The minimum value you should use in the design of your coils should be a wavelength of 222 meters and the maximum should be 550 meters.

* * *

QUESTION: Can dry-cells be used to light the filaments of the ordinary 6-volt vacuum tubes, or will they burn too bright or too dim?

J. S. KNOGHT

ANSWER: Dry-cells can be used with the ordinary tubes but their use is not recommended because they will run down too quickly. The current drawn from the batteries is too high for the dry-cells to furnish for any length of time. Another drawback is the fact that the dry-cells when they begin to be exhausted fall in voltage very quickly, but when they are rested for a short time, they "pick up" and when the tubes are turned on again the voltage is liable to be high enough to burn out the filaments. It is better to use the tubes which are specially designed for the use of low voltages and low lighting currents, as the batteries will last longer.

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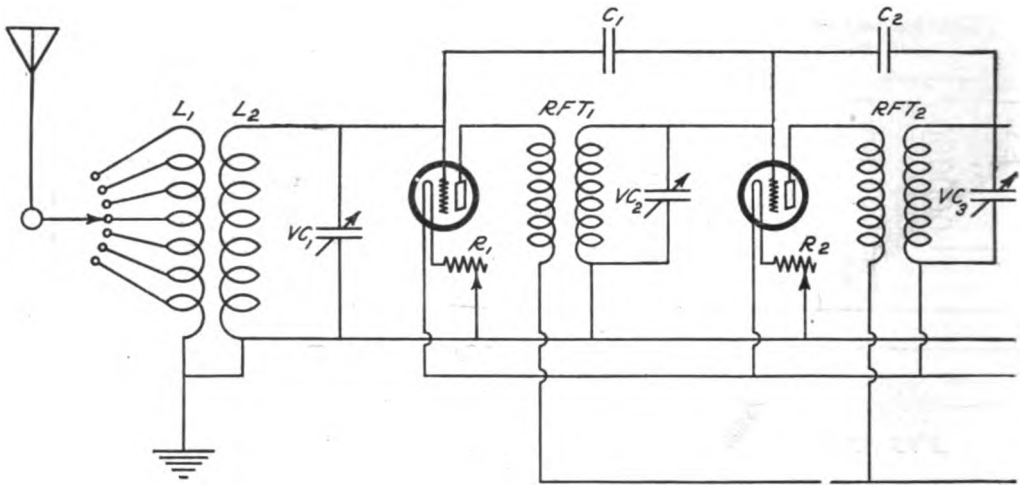

QUESTION: I would like to get a diagram of the hook-up of the "neutrodyne receiver." Will you give it to me, together with list of the instruments necessary? I want to use two stages of neutrodyned radio frequency amplification, vacuum tube detector, and two stages of audio frequency amplification. Also let me have enough information as to the sizes of the coils so that I can construct them.

A. S. WORTH

ANSWER: The circuit diagram (Figure 3) contains the hook-up you have asked for. The parts necessary are the following:

L1 and L2—primary and secondary coils, respectively of an ordinary variocoupler;
VC1, VC2 and VC3 vernier variable condensers, .0005 mfd.;
C1 and C2—neutrodyne condensers;
C3—mica fixed condenser, .0005 mfd.;
R1, R2, R3, R4, and R5—filament rheostats;
J1 and J2—double-circuit jacks;
J3—single-circuit jack;
GL—grid leak, 2 megohms;
GC—mica fixed condenser, .00025 mfd.;
RFT1 and RFT2—special radio frequency transformers;
AFT1 and AFT2—audio frequency amplifying transformers.
Suitable "A" and "B" batteries.

The two neutrodyne condensers may be made by slipping two lengths of No. 14 solid copper wire into opposite ends of a piece of varnished cambric (spaghetti) one inch in length. When the set is put into operation the distance, between the two pieces of wire inside the tube, is varied until the circuits cease to oscillate when tuned to a particular wavelength.

The two transformers RFT1, and RFT2, are made by winding the primary coil, consisting of 16 turns of No. 24 SSC copper wire on a tube 3 inches in diameter. The secondary coil consists of 60 turns of No. 24 SSC copper wire on a composition tube 3½ inches in diameter. The primary coil is then fastened inside of the secondary coil and the two coils mounted at an angle of 30 degrees from the perpendicular.

* * *

QUESTION: What is a radio goniometer?

J. H. B.

ANSWER: The instrument referred to is known by the more popular name of direction-finder. It consists of a special receiving set for use with a loop antenna which revolves on a vertical axis and which picks up signals in one vertical plane only. By revolving the loop until there is a minimum of sound received in the receiver, the direction of the transmitting station may be determined from the receiving station. The most important use of the radio goniometer is to give bearings to a ship at sea in foggy weather.

* * *

QUESTION: Will you please tell me where I can obtain the necessary information to enable me to construct at home a receiver similar to the Aeriola Senior single-tube receiver? How much should this cost me to build?

C. S.

ANSWER: You will find the necessary data contained in an article on page 49 of the July (1923) issue of POPULAR RADIO. The set should cost you no more than $16 if you make all the parts yourself.

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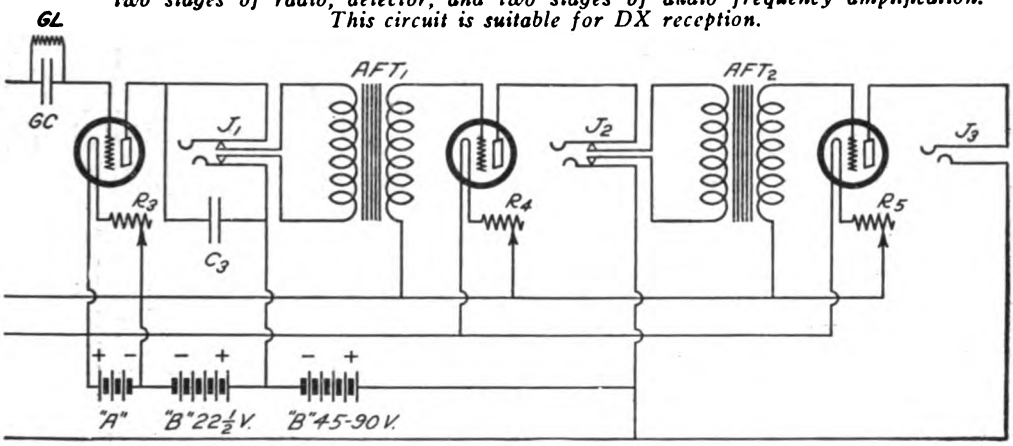
FIGURE 3

The neutrodyne system of radio frequency amplification employing five tubes for two stages of radio, detector, and two stages of audio frequency amplification. This circuit is suitable for DX reception.



QUESTION: Will you please give me a good transmitting circuit for one bulb and a CW transformer for using AC on the plate? I want a circuit that is easy to get into operation and one that does not cost much to construct.

REGINALD HADDEN

ANSWER: The diagram in Figure 4 contains the circuit for your set. You will need a CW inductance L1, with four clips, a mica fixed condenser C1, .001 mfd., a mica fixed condenser C2, .0005 mfd., a paper fixed condenser C3, .1 mfd., and a mica fixed condenser C4, .001 mfd., a L-200 honeycomb or duolateral coil, and a grid leak of approximately 5,000 ohms resistance. The transformer may be one of several types on the market for supplying both the filament current and the plate current. C5, is a counterpoise antenna which should be at least as large as the antenna proper. The key (for telegraph) should be inserted in series with the primary of the CW transformer.

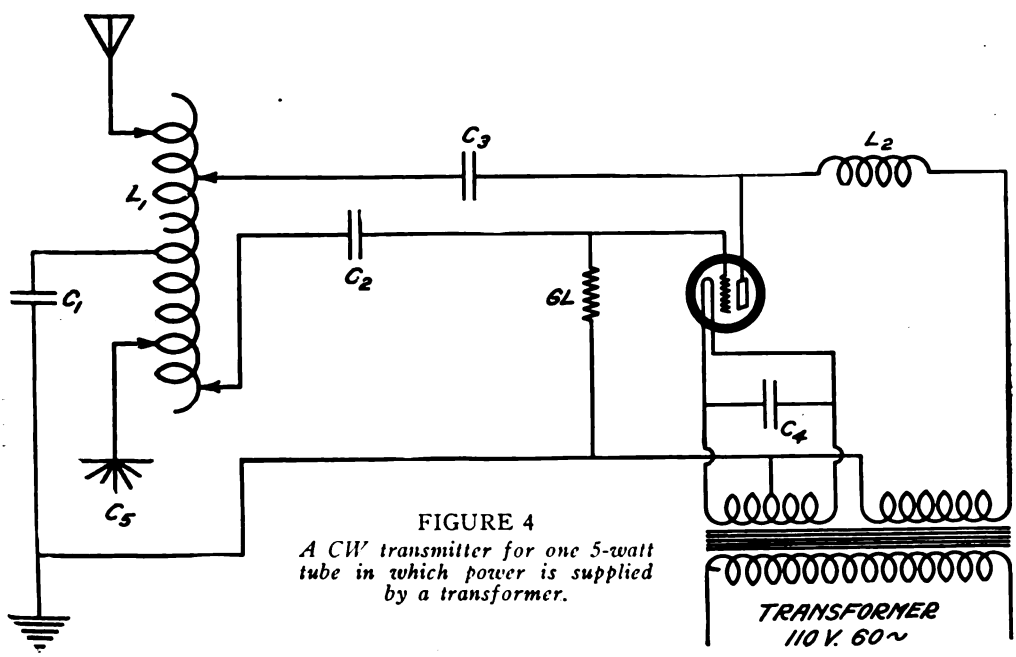


FIGURE 4

A CW transmitter for one 5-watt tube in which power is supplied by a transformer.

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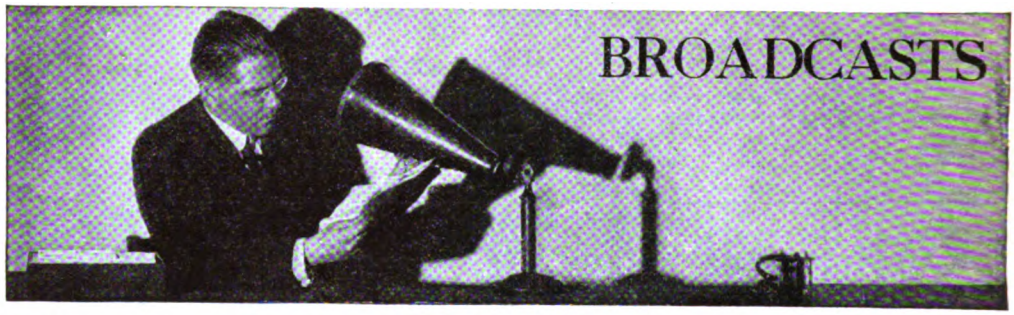

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

5,000,000 Fans Hear the President Speak

OVER 5,000,000 people are estimated to have listened in when President Harding's speech was broadcast by means of the pick-up system from a large hall in St. Louis a few weeks ago.

This experiment, which the average radio fan took as a matter of course, was really one of the most important in the history of communication in general and broadcasting in particular. It represents the successful solution of many perplexing transmission problems, which in the immediate future will mean that one man will be in a position to practically address the entire nation.

In this particular case the hall at St. Louis was equipped with microphones which in turn were connected to the transcontinental telephone lines. A connection was made to station KSD, in St. Louis, which broadcast the speech for the benefit of fans in that city and the middle west. The eastern end of the transcontinental line was connected to station WEAF, in New York City and the speech broadcast for eastern fans.

This test—which was over the greatest distance ever attempted with a broadcast station—coming immediately after the experiment whereby four different radiophone stations were linked up by telephone wires to a hall in New York City, shows the rapid steps being made toward the goal of national broadcasting.

At the present time such broadcasting involves tremendous expense, and is justified only upon the ground of experimentation.

* * *

A Stream of Water as an Antenna

EXPERIMENTS were conducted by the Bureau of Radio Research of the French Navy using streams of salt water pumped up from the sea and shot in a column into the air, which proved that transmission could be accomplished when employing this medium as an antenna. The regular transmitting apparatus was connected to the stream and communication was carried on over a distance of eight miles.

The use of sea water as an antenna is far less efficient that the regular metallic ship's antenna, but it would be found useful in case of an emergency in wartime if the regular antenna were shot away during an encounter.

* * *

The Radio Bug Begins to Bite Italy

THE prospect of initiating a broadcasting service in Italy appears to be somewhat more encouraging than it has been as "the wall of opposition which thwarted every radio plan has been demolished by the Fascist Government," according to *The Tribune*, New York. One company has agreed to pay a specified tax to the government in return for authority to start a broadcasting service; it proposes to tax its subscribers, but just how funds will be raised from this source is not revealed.

The proposed government tax on amateur transmitting sets will vary according to the power of the apparatus.

* * *

How Sweden Proposes to Regulate Broadcasting

SWEDEN will interpose no such handicaps upon its radio fans as have some other European countries, if the proposed law for regulating radiotelephony goes into effect. It will permit amateurs to build their own sets, requiring only that these shall be constructed in accordance with certain regulations. The Telegraph Department does not contemplate limiting within narrow margins the wavelengths on which amateurs may receive. The government proposes to erect the broadcasting stations and rent them to the Radiotelephone Company, which in turn will receive a rental from receiving stations.

No mention is made in the law regarding sending apparatus. The Telegraph Department will control receiving sets and supply them with a certain control mark, whereas the Radiotelephone Company will give permission to use such against payment of a license fee, 10 percent of which reverts to the state for the control privilege.

* * *

6,000 New Fans Monthly in England

ACCORDING to report, 6,000 radio fans a month are applying for receiving licenses in England, despite the red tape and rules governing reception of broadcasting.

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A Paper that Depends Upon Radio for Its News

A NEWSPAPER that depends upon radio for its editorial matter is a unique venture recently undertaken in Alaska.

The Federal Government has recently decided to install a radio station at the Mayo silver camp in the Yukon district, thus establishing direct communication with the outside world. With such connections established, permitting the receiving of important news without a corps of reporters, it has been made possible for a publishing firm to ship a complete newspaper and job printing plant to Mayo City.

* * *

Radio Messages from Atoms

RADIO messages from the inside of atoms are our only hope, the scientists say, to find out what the ultimate structure of matter is like. Each atom sends out, especially when it is excited by a strong electric field, a set of ether waves of absolutely definite wavelength. The tuning, radio fans would say, is perfect. These waves are what appear as the "lines" of the spectrum, both the ordinary spectrum of light and the analogous spectrum of X-rays, which rays are the same as light, or, for that matter, as radio waves of any kind, except that their wavelengths are shorter. These ether waves that come out from the atom correspond, the scientist believes, to features of its internal structure and will enable us, in time, to discover what this structure is.

* * *

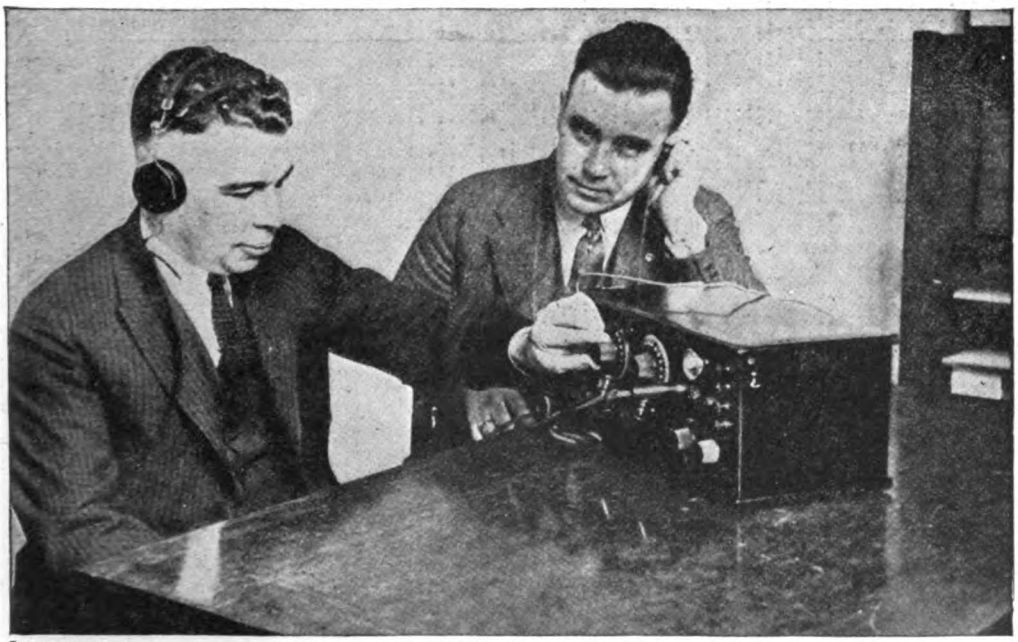
Do Our Ears Vary in Sensitivity from Day to Day?

WHEN you cannot pick up distant stations as well as usual the trouble may be due not to any fault of the radio transmission or with the functioning of your own set, but to changes in your own ear. A German experimenter, Professor Martin Gildemeister, has discovered, according to the *Journal of the American Medical Association*, that the acuteness of human hearing varies from day to day according to the health of the hearer. This is manifested most clearly in an ability to hear slightly higher tones on one's good days than on one's poor ones. The difference may be as much as 200 vibrations a second.

* * *

Does Electricity Keep Alive the Cells in Our Bodies?

ELECTRICITY grows more and more in importance as our knowledge of it increases. Scientists have been saying for a few years that all matter is made of electricity, that is, of electrons. Now comes a Philadelphia chemist, Dr. C. A. Butts, who believes as a result of his experiments that electricity inside the living cells of our body keeps them alive



International

THE FIRST JUDGE TO TRY A CASE BY RADIO

Judge John Rounds, of the Conciliation Court in St. Paul, Minn., is probably the first judge in the world to try a case by radio. Frank Yost suing C. E. Kopp for a radio set; Kopp had refused to pay for the set because he charged it "would not pick up distant stations." The judge could not tell what it would or would not do so he adjourned court and went to Kopp's house to listen in.

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and in good health. On the other hand a little excess of positive electricity in the cells is so dangerous, Dr. Butts believes, that it may cause cancer.

* * *

Radio Music As a Curative

ONE by one the things we think are new turn out to be old. Music received by radio has been found soothing and beneficial, the doctors have been saying, especially to patients in the convalescent wards of the hospitals. Now comes Miss Frances Densmore, who has been studying the native music of the Indians for the United States Bureau of Ethnology, and reports that the ancient medicine men have been using musical rhythms, drum beats and rattles and the like, for many generations for exactly this same purpose. The rhythmic spells chanted by the Indian "doctors" over their patients may have had considerable curative value after all.

* * *

Sending Radio Waves to the Center of the Earth

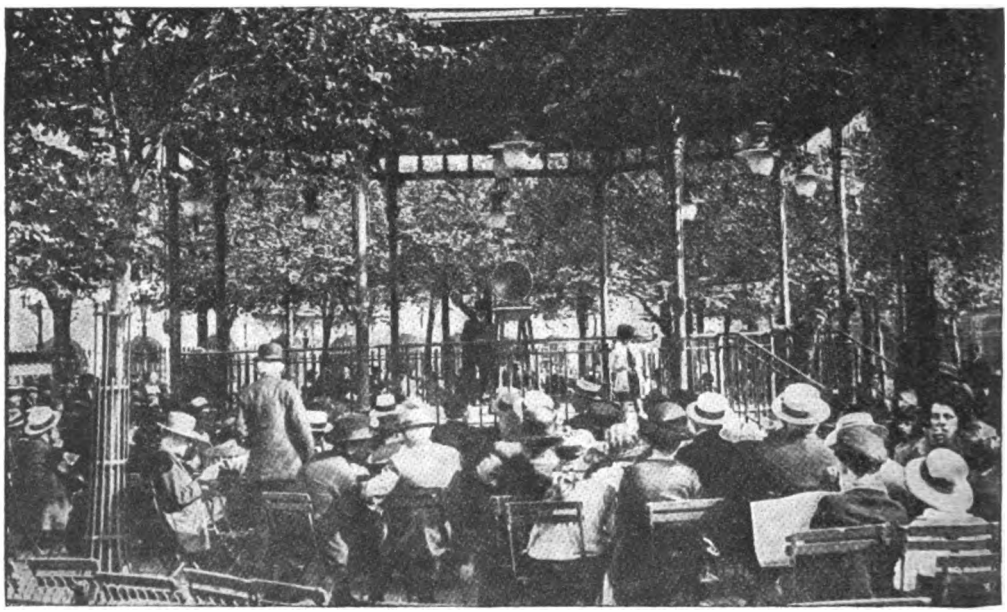
SCIENTISTS now propose to study earthquakes by radio. The way in which the shock from an earthquake is transmitted through the central part of the earth possesses some mysterious features which none of the present scientific theories can explain. To study these earthquake waves directly is difficult because the earthquakes cannot be induced to happen exactly according to schedule, when the scientists are all gathered round in the laboratory and ready to observe them. So it is proposed to explore the nature of the inside of the earth by radio waves instead. Beams of the waves can be directed, the experts think, downward into the ground and from the way these beams are bent or reflected inside the earth much can be learned about what really exists a thousand miles or so down under our feet.

* * *

The Passing of an Old Radio Ether Mark

SEAGOING radio operators, many skippers and landsmen who listen in will note a change in the "voice" of NAA at Arlington. The peculiar tone of the old Fessenden spark will no longer carry the time signals, weather reports and information of interest to mariners; this famous spark set (installed in December, 1912), was replaced recently by a new tube transmitter.

Operating on the same wavelength, 2,560 meters, the new set will carry all the governmental broadcasting that was formerly done on the spark. Although its power is not quite as great, the range of the tube set by tests has proven a little greater than the old 100 K.W. spark. After eleven years of almost constant operation, the Fessenden set is to be retired from active service; it is understood that it may be presented to the National Museum, where many radio experts believe it should have the honor accorded to the early locomotive of Baldwin and the Morse telegraph key.



Kadel & Herbert

RADIO TAKES THE PLACE OF A MILITARY BAND

The band-stands of Paris are losing none of their popularity merely because the musicians are miles away—as the people who gather around them are now hearing better programs played by larger orchestras whose programs are broadcast in many parks at once. This is one of the stands on the Champs Elysée.

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Do not burn the thoriated filament tubes at too great a brilliancy; do not turn up the filament rheostat above normal. This will force too much current through the filament and release the electrons so fast that the filament will become "run out" of free electrons in a short time. The filament will burn all right but there will be little or no signals.

The correct current for the C-301-a, or the UV-201-a, is ¼ ampere.

If your tubes are of the type mentioned above and they have stopped working and still the filaments appear to be in perfect condition you can bring them back to usefulness by burning them at the correct filament current (¼ ampere) for an hour or so without the "B" battery being connected to them. This will cause a redistribution of thorium atoms around the surface of the filament which will again start and maintain the requisite stream of electrons for proper operation.

* * *

When learning the code, do not study by the eye, but do it by the ear. Do not learn that the letter A, for instance, is represented by a dot (•) followed by a dash (—), but, from the first effort to memorize the code, learn that the letter A *sounds* like Dit-Da-a-a-ah (say it with your mouth); the letter B *sounds* like Da-a-a-ah—Dit—Dit—Dit, and so on.

* * *

Do not use acid soldering flux under any consideration.

The loop receiver described in the August issue of Poplar Radio receives up to a wavelength of about 515 meters. It can be made to tune up to the higher broadcasting wavelengths by the addition of two small Telos mica condensers made for this purpose, which are connected directly to the vario-transformers.

* * *

An easy way to sharpen up the tuning in a set is to put up another wire, the same length as the original antenna wire and running parallel with it. The new wire should not be closer than four feet to the first wire.

This will increase the capacity of the antenna system and will allow the use of a smaller coil in the antenna circuit which will decrease the resistance and permit looser coupling.

* * *

Do not use a "B" battery when its voltage drops below 60 per cent of its original value. A battery in this condition will have an increased resistance and will reduce the strength of signals and cause all sorts of extraneous noises. Get a new battery.

* * *

Clean away any excess soldering paste from the terminals of your set with alcohol and save yourself a lot of trouble in finding out what is wrong with the set.

* * *

Make the grid wires in that set of yours as short as possible and keep them isolated from the other circuit wiring.

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Do not use shellac or any form of binder on the wire of the coils used in the four-circuit tuner. If you leave the coils dry they will work well but if they are covered with any form of insulating paint they are almost worse than useless.

* * *

FOR the radio experimenter, a useful article to have on hand is a small coil of bell wire. This is a copper wire of about No. 18, and it is wrapped with two thick coverings of waxed cotton thread. It comes in handy for connections when experimenting with new circuits.

* * *

A SMALL quantity of vaseline taken on the finger and rubbed on the contacts of a switch will keep the contacts from wearing and grinding themselves away. Contrary to what one would naturally think, this also insures a *better* electrical contact.

This stunt is used in most of the large electrical research laboratories on delicate measuring instruments.

* * *

KEEP the distilled water in your storage "A" battery just above the level of the plates. If you do this the top part of the plates will remain "active"; if you do not, the portion above the water-line will not generate any current and you will have lost part of the ampere-hour capacity of the battery—it will not last as long for each charge.

* * *

IN wiring up a set it is a good plan to use little copper tabs (obtainable in almost all of the electrical stores) for making connections to the instrument terminals and the binding posts. The tabs are inserted underneath the screw of the binding posts and the wires soldered to the tab. Then if you want to tear the set apart to try some other circuit you do not have the instruments all gummed up with solder. The tabs come away *clean*.

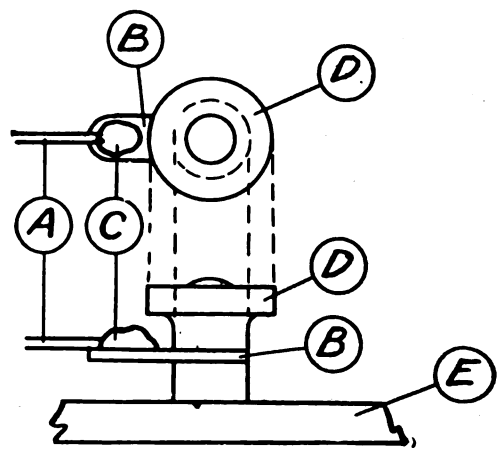
ALWAYS turn down the rheostats when you first connect up a new set that you have just completed, and try out a single tube in the sockets before putting in all the tubes. This will save two or three tubes if you have made a mistake in the connections.

* * *

THE condensers used in the four-circuit tuner should be "low loss" condensers, especially the one used in the stabilizer (absorption) circuit. This is extremely important for if the condensers are poor, the losses will be great and the regenerative effect will be lost.

* * *

OIL should not be used on the bearings or movable parts of radio sets. Some (quite a few) of the instruments on the market make use of the metallic bearings for the connections to the movable parts and these would be seriously affected by the film of oil between the bearing surfaces.



HOW TO USE THE TABS

The connecting wire A, is fastened to the copper tab B, by soldering C, and the tab is then inserted underneath the thumbscrew D, of the binding post which is attached to the particular instrument which is being connected in the circuit. This makes a neat connection without marring the instrument. Besides, it is easier to use the tabs as their mass is small in comparison with the whole binding post which must be heated.

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"STATIONS I HAVE HEARD"

If you are getting good results with your receiving set, tell your fellow-readers of POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

WHAT PATIENCE WILL DO WITH A CRYSTAL SET

WITH patience and almost nothing else, Francis L. Urry, in Salt Lake City, Utah, makes his crystal cover a distance of 700 miles as a regular thing. His tapped tuning coil does the work without the assistance of a variable condenser.

He hears five stations in Los Angeles, Cal., 700 miles away—KHJ, KFI, KOG, KWH and KFCL, and three others 500 miles away, KLX, Oakland, Cal., and KPO and KUO, San Francisco, Cal.

* * *

FOUR TUBES NOT ENOUGH

"I CAN tune in almost anything from Calgary to Porto Rico," writes T. D. Goresline of Gardner, Kans., "with my four tubes. Please tell me how to add two stages of radio frequency amplification."

He admits that he is a bug and says he is just getting interested after tuning in 142 phone stations and approximately one million code stations. He is using the "Real DX Receiver" described in the January number of POPULAR RADIO, with a third stage of audio frequency amplification.

* * *

A CHALLENGE FOR ONE-TUBE OPERATORS

WITH a single-circuit tuner that employs a variocoupler and variable condenser, Ted Lehman of Ashland, Ky., thinks he has a record for consistency hearing KFI and KHJ of Los Angeles, Cal., 2,100 miles away. During twenty-four consecutive nights he heard KFI 16 times and KHJ 13 times. His list of ninety-six stations includes three in Canada, two in Cuba, four in Texas and three in Colorado.

"I use a vernier rheostat," he writes, "and turn it until I hear a click in the phones. This is the point at which I get the clearest signals, although I sometimes brighten up the filament for long distances.

THE HIGH SELECTIVITY OF THE FOUR-CIRCUIT TUNER

"I BUILT the Cockaday Four-Circuit Tuner, using a plain wooden panel and no shellac, and I go right through the ether and pick out what I want," says W. K. Young of Kansas City, Mo. Using only one tube he readily tunes in WGY, Schenectady, N. Y.; WSB, Atlanta, Ga.; WFAA, Dallas, Tex.; KFDY, Brookings, S. D., and most of the other powerful stations in between.

* * *

USES POWER TUBE FOR HIS SPEAKER

WITH a detector tube and two stages of audio frequency amplification in a double-circuit regenerative hook-up, Noel Ferree of Hamilton, O., covers the whole of the United States, and with a five-watt power tube, he puts all his stations on a loudspeaker. KFI of Los Angeles, Cal., and PWX of Havana, Cuba, can be heard in a large room adjoining that in which he operates his loudspeaker, he says, and they come in as clear as they can be heard with phones.

* * *

THE NAVY SMILES ON THE FOUR-CIRCUIT TUNER

"I AM much enthused over Cockaday's latest invention," writes E. G. Meister of Buffalo, N. Y. "When I showed it to John C. Haderer, formerly Chief Radio Electrician, U. S. Navy, for a test and a critical inspection, he was so much taken with it that he said he would discard all thoughts of variocouplers and variometers in building future sets, and use only this circuit."

The following stations are a few of the 31 which come in so loud on a loudspeaker that the "B" battery current must be cut down: WDAP, Chicago, Ill.; WBZ, Springfield, Mass.; WMC, Memphis, Tenn.; WBAP, Ft. Worth, Tex.; WSY, Birmingham, Ala., and WLAK, Bellows Falls, Vt.

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WHAT CAN BE DONE WITH A SIMPLE SET

A DISTANCE of 1,100 miles covered with a crystal set made quickly from standard parts is reported by Glenn Grimes of Tuttle, Okla. A variocoupler, a variable condenser, a piece of galena, a phone condenser and his phones enable him to pick up KDKA of East Pittsburgh, Pa.

The night on which he heard Pittsburgh was still and clear. He has often heard WOC, Davenport, Ia.; WBAP, Fort Worth, Tex., and WKY, Oklahoma City, Okla. His antenna is a single wire 120 feet long and 38 feet high.

* * *

HE USES SPIDER-WEB COILS

WHEN properly used, a dry-cell tube in McCreary, Manitoba, Canada, can pick up every broadcast program from PWX of Havana, Cuba, during a period of two weeks, according to Ronald L. Harper.

Three good spider-web coils in a double-circuit regenerative hook-up bring him 121 different stations. He uses an antenna made of a single wire 204 feet long, strung 45 feet above the ground. A grid condenser of .0005 mfds. capacity is a great help in picking up distant stations, he says.

Some of the stations he has heard are KXD, Modesto, Cal.; KWH, Los Angeles, Cal.; KPO, San Francisco, Cal.; WOO, Philadelphia, Pa.; WEAF, New York City; KGW, Portland, Ore.; WSB, Atlanta, Ga., and CFCA, Toronto, Canada.

* * *

30 STATIONS ON A CRYSTAL DETECTOR

NOT claiming to break the distance record for the crystal, but upholding the loose coupler as one of the simplest means of receiving well, Joseph Shearer writes from Buckley, Wash., to say that he has picked up 30 stations, many of which are from 500 to 700 miles away, with his set which uses a loose coupler and a crystal detector.

Shearer built the coupler at home from instructions printed in POPULAR RADIO for July, 1922. He uses a 43-plate variable condenser in the antenna circuit, and his antenna is 175 feet long and 50 feet high. His phones are of the 3,000-ohm type.

He hears KDN, KUO, KPO and KFDB of San Francisco, Cal.; KFCL and KHJ of Los Angeles, Cal.; KDYL and KZN of Salt Lake City, Utah; KDYS of Great Falls, Mont., and CFCN, CFAC and CHCB of Calgary, Alta., Canada.

* * *

156 STATIONS ON TWO TUBES

WITH two tubes in a set that employs three honeycomb coils, W. C. Aylesworth of Bridgerville, Pa., reports hearing 156 stations with new ones coming in every day. The coils he uses are the usual primary, secondary and tickler, and the amplification is audio frequency.

Among the distant stations are KOP, Detroit, Mich.; KDZW, San Francisco, Cal.; WGI, Medford Hillside, Mass.; PWX, Havana, Cuba and CJGC, London, Ontario, Canada.

HE IDENTIFIES 190 STATIONS

BURDETTE M. SMITH of Le Mars, Ia., has received and positively identified 190 stations since last November and he reports that he uses only three tubes. His trick lies in skillful manipulation of a good single-circuit receiver. He finds that he must tolerate considerable interference, much more than would be necessary with a double-circuit tuner, but he covers the whole continent and he is satisfied. With the new wavelengths he is getting less interference, and he is out for a new record with three more tubes for radio frequency amplification.

His set employs a variocoupler and primary condenser, both of the vernier type, in a regenerative hook-up, with a detector tube and two stages of audio frequency amplification. His aerial is 45 feet high and 175 feet long, including the lead-in. Storage battery tubes are used throughout.

On April 18, between the hours of 8.15 and 11.45, he managed to pick up 37 stations including WOC, Davenport, Ia.; WJZ, Newark, N. J.; KFDY, Brookings, S. D.; WGV, New Orleans, La.; WBAP, Ft. Worth, Tex.; KPO, San Francisco, Cal.; KWH, Los Angeles, Cal., and CFCN, Calgary, Canada.

* * *

HIS EXTRA TUBES ARE USELESS

E. KAMPF of Washington, D. C., has five tubes in his set, but he uses a detector and one stage of audio frequency amplification almost exclusively. He finds that his radio frequency amplifiers do not work well with an outdoor antenna and his single-circuit regenerative hook-up, and even with a loop antenna they make his hook-up too complicated for efficiency. With two tubes, however, he receives 129 stations, covering a good half of the continent.

* * *

MAKES RECORD WITH AN OLD CIRCUIT

THE old stand-by circuit which is usually voted as the easiest to construct from standard parts when long range and general good reception are desired, is lauded by Maitland and Spencer Roache of Philadelphia, Pa. It is the regenerative circuit using a variocoupler and two variometers with three tubes and a single wire on the roof. The Roache set brings in 80 cities in the United States, Canada and Cuba, with a total of 60,000 miles.

* * *

COCKADAY MAKES HOLLYWOOD FAMOUS

THE first record of coast-to-coast reception with the Cockaday Four-Circuit Tuner built from the description in the May number of POPULAR RADIO comes from Hollywood, Cal. W. Russell has picked up PWX of Havana, Cuba, several times.

"I have yet to find any one getting better results no matter what equipment he has," writes Russell. "I never saw a better set."

He receives CFCN of Calgary, Canada; WBAP of Ft. Worth, Tex.; WOC, Davenport, Ia., and a long list of others throughout the country, using only one stage of amplification. His aerial is 30 feet high and 250 feet long, running north and south.

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THE beautiful tone of a Stradivarius or the wonderful technique of a famous voice cannot be reproduced by inferior headphones.

The successful performance of your receiving set depends upon the quality and perfection of the headset you purchase.

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This light weight, sanitary set reproduces positively and faithfully with an exceptional purity of tone and extreme sensitiveness.

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If your dealer is unable to supply you, write us direct, giving us his name

We shall be pleased to send you a copy of our booklet, "What You Should Know About Radio Reception."

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ACE

Type V

Armstrong Regenerative Receiver $20

Formerly known as Crosley Model V

For performance no receiver at its price can equal it

An Evansville, Ind., man writes, "The other night I tuned in Kamach, Hawaii, and held the concert for one hour. The music was clear and the speaking distinct." This is indeed a tribute to efficiency.

Ace Receivers are licensed under Armstrong U. S. Patent 1,113,149.

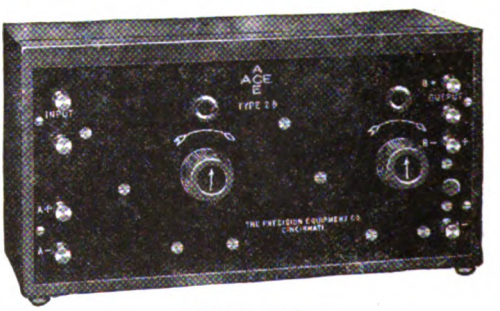
All Ace sets are equipped with the Crosley multistat, the universal filament control rheostat, for all makes of tubes.

Wave length range 200 to 600 meters.

Ace Instruments perform all we claim—and more besides.

Live Jobbers and Dealers are eagerly taking advantage of the sales these instruments and the other Precision instruments and parts are bringing them.

Free catalog on request



ACE Type V

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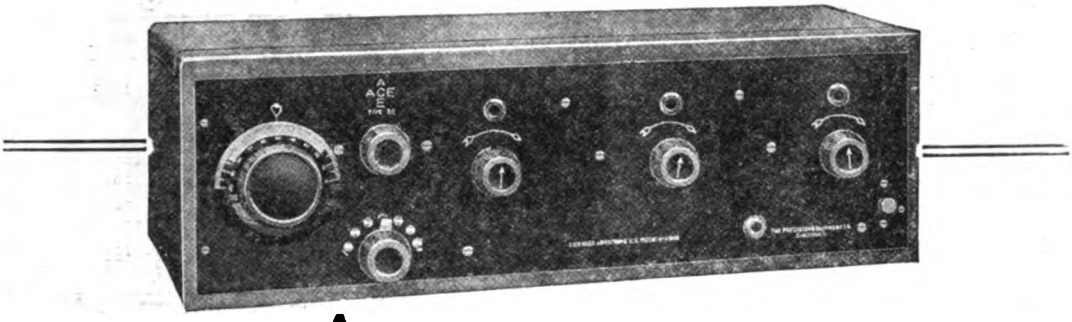
A New Radio Triumph



ACE TYPE 3B

Wide Range—Steady Performance—Sure Results

IN any field of endeavor, there is always one concern that seems to continually outstrip the others in new improvements.

In its Ace Type 3B, The Precision Equipment Co. offers the most remarkable 3 tube radio receiving set on the market. Without hesitation, we claim that the Ace 3B will out-perform any other set of its class and many that cost two and three times as much.

The Ace 3B is a regenerative receiver licensed under Armstrong U. S. Patent 1,113,149. It contains a detector unit and 2 stages of audio frequency. In addition, it uses all the new Crosley features such as filament switch, jack, new Crosley molded sockets and condenser with molded plates. Price $50.

A special battery Cabinet has been built to fit the Ace 3B. It is a beautiful piece of mahogany furniture in which all the necessary batteries can be stored. Price $15.

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M812—43 plate .001 Mfd..... $1.73
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These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with any inferior cheap condensers offered. We guarantee them to please you or your money back.

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The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning. High-grade design and construction. Finely finished. Suitable for panel mounting.

INDUCTANCE "HONEY COMB" COILS

Carefully made — fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Meters	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	M301	$0.39	M320	$0.89
35	175- 450	M302	.42	M322	.96
50	240- 720	M303	.49	M323	1.04
75	390- 910	M304	.54	M324	1.08
100	500- 1450	M305	.58	M325	1.13
150	600- 2000	M306	.63	M326	1.17
200	900- 2500	M307	.72	M327	1.26
250	1200- 3500	M308	.78	M328	1.35
300	1500- 4500	M309	.82	M329	1.36
400	2000- 5000	M310	.97	M330	1.57
500	2800- 6100	M311	1.12	M331	1.63
600	4000-10000	M312	1.27	M332	1.78
750	5000-12000	M313	1.43	M333	1.93
1000	7900-15000	M314	1.70	M334	2.28
1250	9750-19500	M315	1.92	M335	2.49
1500	14500-26500	M316	2.18	M336	2.65

COIL MOUNTINGS

M340—Three coil mounting..... $3.95
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High grade fine looking mounting. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. M732—Each..... 59c

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Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.
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Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs.
M140—For Standard Base Tubes. Each..... 39c
M108—For WD11 Tubes. Each... 49c

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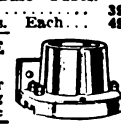


M144—Crosley for either panel or table mounting for Standard Base.. 36c

High Grade combination type for panel or table mounting Metal tube. Highly insulated base. For Standard Base Tubes.
M146—Each..... 45c

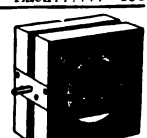
GRID CONDENSER

M162—Mounting holes spaced to fit lugs of above leak Cap. .00025 MFD..... 8c
M163—Same as 162 but higher grade. Enclosed in metal case..... 39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
M100—Each..... 19c

VARIOMETER



M410—Completely assembled, price $2.10

Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings, positive contacts. Highest efficiency.
M411—Not assembled but all parts complete, except wire, including winding form..... $1.48

VARIO-COUPLER

With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.
M415—Price, completely assembled.. $2.45
M416—Not assembled, but all parts complete. Price, except wire..... 1.18
M417—Rotor ball only. Each..... 29c
M408—Bakelite Stator tube only. Ea. 35c

RADIO FREQUENCY AMPLIFYING TRANSFORMER

M995—Each..... $3.95

This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling, due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.
M234—10 to 1 Mounted. Each... $3.48
M235—10 to 1 Unmounted. Each. 2.95
M236—3 to 1 Mounted. Each.... 3.40
M237—3 to 1 Unmounted. Each. 2.85

FILAMENT CONTROL RHEOSTATS

Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
M130—Each..... 45c

Best grade. High heat resisting base. Diam. 2½ in. cap. 1½ amp. Resistance 6 ohms. 1¼ in. Knob with pointer.
M132—Each..... 45c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 200 or 400 ohms.
M133—Each..... 98c

VERNIER RHEOSTAT

Gives exceedingly fine control of a battery current. A necessity for best receiving results.
M135—Each..... 89c

PLATE CIRCUIT "B" BATTERIES

You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

M180—Signal Corps type, small size, 15 cells. 22½ volts. Each..... 95c
M184—Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each..... $1.80
M188—Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Ea. $3.55

DETECTOR CRYSTALS CAREFULLY TESTED

M736 Galena, Arlington tested, per piece 19c
M 738 Silicon, Arlington tested, per piece 19c
M735 Tested, Galena, per piece..... 9c
M737 Tested, Silicon, per piece..... 9c

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

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USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE — THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
M240—100 ft. coil 49c
M242—500 ft. coil $2.35

Solid Bare Copper Wire, size 12
M244—100 ft. coil 67c
M245—500 ft. coil $3.05

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

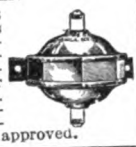
M248—100 ft. coil 72c
M249—500 ft. coil $3.20

ANTENNA INSULATORS

M260 M262 M264-6

M260—Size 1x3¼. Two for..... 17c
M262—Size2⅛x3¼ Two for..... 55c
M264—Size 1½x4. Two for..... 69c
M266—Size 1½x 10½. Two for $1.29

OUTDOOR LIGHTNING ARRESTER



M980—Price.....$1.58
Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES

Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

M385 Single Pole Single Throw. Each 20c
M383 Single Pole Double Throw. Each 32c
M384 Double Pole Double Throw. Each 50c

SWITCH LEVERS

Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

M380—1" Radius } Each
M381—1¼" Radius } 15c
M382—1½" Radius }

SWITCH LEVER STOP

Brass, polished nickel finish.
M386—Dozen 18c. Hundred $1.05.

ONE-PIECE DIAL AND KNOB

Moulded of highly polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

M900—2¼" Diam. for 3-16" shaft. Ea.19c
M901—2¼" Diam. for ¼" shaft. Ea..19c
M904—3" Diam. for 3-16" shaft. Ea..25c
M905—3" Diam. for ¼" shaft. Ea...25c
M906—3½" Diam. for 3-16" shaft. Ea.35c
M907—3½" Diam. for ¼" shaft. Ea..35c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS

Finest grade jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks only
M390—Open circuit. Each..43c
M391—Closed circuit. Each.49c
M392—Two circuit. Each..60c
M393—Single-clr. flla. control.69c
M394—Two clr. flla. control..85c

M395—Plug. Large space with set screws for attaching cord. Each.....35c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard jacks and Plugs. Solder connections. Nickel finished metal parts.

M387—Open Circuit Jack. Each..27c
M388—Two Circuit Jack. Each....35c
M389—Standard Plug. Each.....35c

BINDING POSTS

M370-2 M376-8

Brass, polished nickel finish. Washer and 6-32" screw extending ⅜".

M370—Large size—barrel and knob ¾" long, dozen.....85c
M372—Smaller size—barrel and knob 9-16" long, dozen.....70c
M374—Large size with composition knob. dozen.....50c
M376—Large size with hole for phone tip or wire, dozen.....80c
M378—Small size with hole for phone tip or wire, dozen.....35c

STORAGE BATTERY

A very high grade battery made especially for radio Service. Guaranteed. Properly cared for will give years of service for filament lighting.

M194-6v.,40 amp. size. Each..$10.00
M196—6-v.,80 amp. size. Each. 12.50
Price does not include transportation

CABINETS

Fine-looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	M420	$2.48
6x10½"	5½"	10"	7"	M422	2.75
6x10½"	5½"	13½"	7"	M424	3.30
6x14"	5½"	13½"	7"	M423	3.60
7x14"	6½"	13½"	7"	M426	3.90
7x18"	6½"	17½"	7"	M425	4.20
7x21"	5½"	20½"	7"	M428	3.70
9x14"	8½"	13½"	10"	M430	4.40
12x14"	11½"	13½"	10"	M432	5.25
12x21"	11½"	20½"	10"		

SOLID GENUINE CONDENSITE CELERON PANELS

Notice our very low prices in this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished. Black finish which can be sanded and oiled for extra fine work.

Size Inches	Panel ⅛" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No.	Price
6x 7	M450	$0.50	M460	$0.75	M470	$0.98
6x10½	M451	.75	M461	1.18	M471	1.47
6x14	M452	1.05	M462	1.55	M472	2.05
7x14	M458	1.20	M468	2.60	M478	2.40
7x18	M453	1.55	M463	2.30	M473	3.10
7x21	M457	1.78	M467	2.65	M477	3.60
9x14	M454	1.60	M464	2.30	M474	3.10
12x14	M455	2.10	M465	3.10	M475	4.15
12x21	M456	3.15	M466	4.65	M476	6.20

HOME CHARGER BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips.

Prices are Transportation Paid.
M201—For 6 volt battery.....$12.95

BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellen with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

M770—2000 ohm.....$3.75

OTHER STANDARD BRAND HEADSETS

M751—Murdock 56, 2000 ohm.....$4.20
M752—Murdock 56, 3000 ohm.....4.95
M764—Frost, 2000 ohm.....4.20
M766—Frost, 3000 ohm.....4.85
M756—Red Head, 3000 ohm.....5.78
M758—Western Electric, 2200 ohm.$9.50
M754—Baldwin Type C with plug. 11.75
M755—Baldwin Type C unit.....5.50
M768—Brandes, Superior.....5.40
M769—Brandes Navy.....6.95

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

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Give the Boys the Credit

RIGHT on the shoulders of America's boys and young men rests the success of the radio business. It is their curiosity, their ceaseless energy, their enthusiasm, that have sent radio surging over the entire country to the tune of more than two and a half million sets.

It's the boys that are keeping the retailers' stores crowded with eager buyers. Their home-made sets are the seeds from which have sprung the fine expensive sets the grown-ups buy. They've inoculated their parents with the radio virus. Dad says, "If we're going to have radio, we'd better have it right," and straightway starts out on a radio hunt, with his son acting as guide, adviser, buyer and constructor.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

takes the radio manufacturer's message right to 500,000 enthusiastic, energetic, go-getting boys in well-to-do families. It places his product before an army of youth, averaging 15½ to 16 years of age. It reaches them at an age when their knowledge of radio is respected by their elders; when their buying power is ever growing to greater proportions; when they're forming buying habits of a lifetime for themselves.

By advertising in THE AMERICAN BOY you not only win a great army of ready buyers for your product, you enroll just that many energetic, boosting salesmen.

Copy reaching us by September 15th will catch the November issue.

THE SPRAGUE PUBLISHING COMPANY
(Member A.B.C.)
548 Lafayette Boulevard, Detroit, Michigan

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Just Out!

The New RADIO BATTERY EVEREADY "THREE"

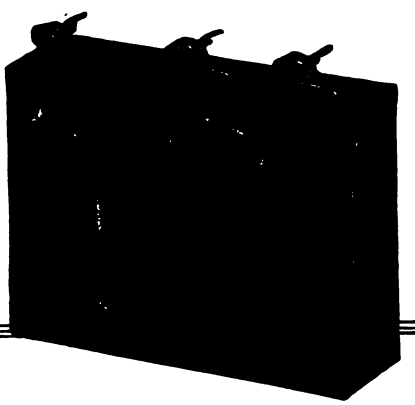
THREE CELLS ~ THREE TERMINALS ~ THREE PURPOSES

May be used—

As an "A" Battery for portable sets having UV-199 Tubes.

As a "B" Battery for obtaining additional "B" Battery voltage.

As a "C" Battery for furnishing negative potential to amplifying Tube Grids.



Eveready "Three" has three Fahnestock Spring Clip Connectors making it possible to secure 1½, 3 or 4½ volts from the battery.

Ask your dealer or write us for circular No. 1025 giving complete information on this NEW Three Purpose RADIO BATTERY. Order Eveready "Three" by catalog number 771.

Made by the largest dry battery manufacturers in the world—makers of the famous

Eveready Storage "A" Batteries for Storage Battery Tubes;
Eveready Dry Cell Radio "A" Batteries for Dry Cell Tubes;
Eveready "B" Batteries for all Vacuum Tubes.

NATIONAL CARBON COMPANY, Inc.
Long Island City, N. Y.

Atlanta Chicago Cleveland Kansas City San Francisco

See our exhibit at Radio Show, Grand Central Palace, New York City, October 6-13

RELIABLE **EVEREADY Radio Batteries** NOISELESS
—they last longer

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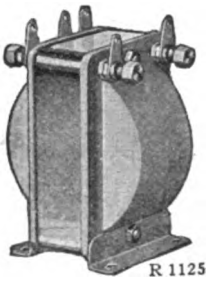
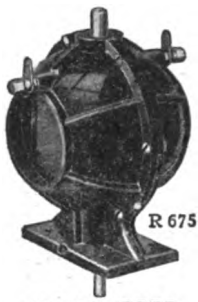


R 1125

AUDIO FREQUENCY TRANSFORMER

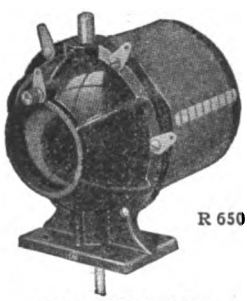
Exceptionally well made and dependable. Completely shielded in aluminum case.



R 675

VARIOMETER

Embodying the highest electrical efficiency. Moulded brown bakelite, split bronze bearings. Obtainable in two sizes.



R 650

VARIOCOUPLER

The finest that can be produced. Moulded brown bakelite, split bronze bearings; winding tapped at 15 points for very close tuning. Obtainable in two sizes.

for perfect reception use

Gilfillan Radio Parts

If you want most satisfactory results use "Gilfillan" parts in your Radio set. Accurately made of finest materials in accordance with the latest scientific standards.

Have your dealer show you Gilfillan Radio Parts. A few of them are illustrated here. You'll find them to be just what you want—and extremely low priced for quality construction.

If your dealer can't supply you with Gilfillan parts, write us for descriptive folder and price list.

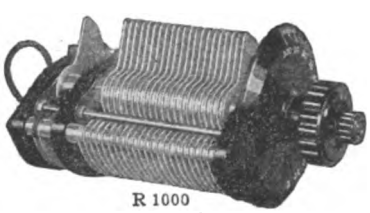
DEALERS: Gilfillan Radio Parts offer a splendid merchandising opportunity. Write us for detailed information.

GILFILLAN BROS., INC.

1815 W. 16th St., Los Angeles, Cal.
1925 McGee St., Kansas City, Mo.
225 W. 57th St., New York, N. Y.

Genuine Gilfillan Radio Parts carry this trade-mark. Look for it.

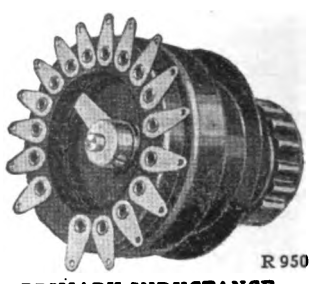
GB



R 1000

CONDENSER

With Vernier and pigtail connection. Obtainable in 43 plate, as above and 23 plate sizes.



R 950

PRIMARY INDUCTANCE SWITCH

15 point. Provided with solder lugs. Moulded bakelite, black knob and dial.

Gilfillan Radio Parts are not sold for use on patented circuits.

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Haynes-Griffin

RADIO SERVICE, Inc. **41 West 43rd St., N. Y. City**

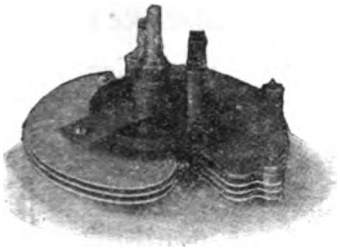
A. J. HAYNES
Assoc. Institute of Radio Engineers
Designer of the Haynes Circuit and the Haynes Selector

THE HEART OF THE FAMOUS HAYNES CIRCUIT

The Identical Parts Used by Mr. Haynes in His Own Personal Receiving Set—Assuring the Utmost in Selectivity, Long Distance Range, Economy and Simplicity of Arrangement. Invaluable to experimenters converting ordinary simple regenerative sets to include the Haynes Circuit.

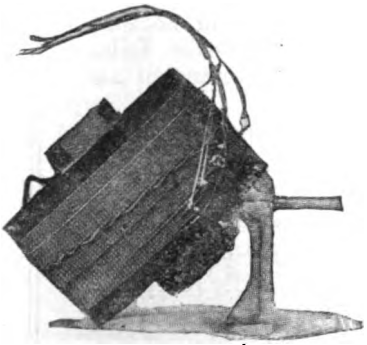
GET the full value from your Haynes Circuit by using only the special Haynes Condenser.

Meets every requirement—extreme low minimum capacity and maximum capacity of exactly .00023 mfds. Designed primarily as a secondary tuning condenser of the highest precision, it became the heart of the Haynes Circuit. No other condenser is exactly like it, no other achieves just the right balance between perfect selectivity and overcritical adjustment.



The Haynes Condenser $3.50

Second in importance is the vario-coupler. Any good coupler will do, but the Haynes bank wound coupler has been designed to assure absolutely perfect results. Supplied with necessary adaptations already made. Furnished with only the taps you actually use and just the right number of turns on the secondary. You can't possibly go wrong. Leads already attached and soldered. Bank winding provides 100% efficiency on higher broadcasting wave lengths.



The Haynes Bank Wound Coupler . $4.35

1000 Miles for $15.00

The outstanding feature of Mr. Haynes' own set is its simplicity and compactness of arrangement with all the instruments panel mounted.

Most experimenters find it well worth their while to substitute parts recommended by Mr. Haynes for those they may have on hand.

Haynes .00023 Condenser	$3.50
Haynes Bank Wound Coupler	4.35
Fada Rheostat	.75
Fada Socket (Panel Mounting)	1.00
Switch Arms	.20
4 Switch Points and 2 Stops	.06
10 Binding Posts	.50
2 3-inch Dials	.90
1 Dubilier Grid Condenser .00025 mfds. (with leak mounting)	.45
1 Grid Leak 1 meg	.35
Bus Bar, Solder, Copper Lugs and all miscellaneous material	.55
7x15 Grade A Hard Rubber Panel	1.50
Panel Drilled for Mounting all the above instruments (extra)	1.50

Accessories

7 x 15 solid mahogany cabinet, piano finish, $4.25; Haynes-Griffin Head Phones (2200 ohms) $4.75; W. D. 12, U V 201 A or U V 199 Vacuum tubes, $5.85; 22½ volt variable B Batteries, $1.25; 1½ volt dry cell A batteries, 35c each.

All these items are in stock—prompt shipment will be made—carriage charges prepaid

HAYNES-GRIFFIN RADIO SERVICE, Inc. 41 W. 43rd St. New York City

New York's Largest Radio Store

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Another Use For Loud Speaker

When the static is too great for radio reception your AUDIOPHONE Loud Speaker can be used with the Bristol Phonograph Record Reproducer on your phonograph. Then you may have concert or dance program without interruption.

Attached instantly without mutilating the instrument in any way—the Bristol Phonograph Record Reproducer can be used with any make of phonograph.

Equipped with such an outfit there are no disappointments—it is always ready—never fails. For dance music you have the equivalent of an orchestra, but without the expense.

The tone of the phonograph thus amplified through the AUDIOPHONE has volume enough to fill large rooms and the quality is round—smooth—and beautiful—entirely free from mechanical noises.

Remember that the same AUDIOPHONE Loud Speaker is used in common for both radio reception and phonograph record reproduction.

TRADE MARK
AUDIOPHONE
REG. U. S. PAT. OFFICE

Write for Bulletin 3007-L and we will advise where you may hear a demonstration.

THE BRISTOL COMPANY
WATERBURY, CONN.

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Boston New York Pittsburgh Philadelphia
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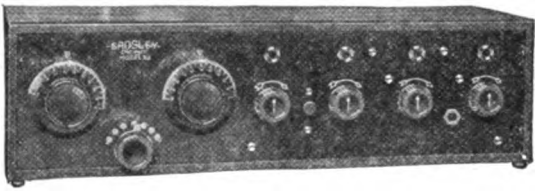
CROSLEY EFFICIENCY INCREASED

Price
$65



The New Crosley Model X-J

THE Crosley Model X, famous throughout the United States for perfect performance, is now offered to you with even greater refinement of detail in the new Crosley Model X-J.

Some of the new features of the Crosley Model X-J which make for greater distinction and beauty are:

1. Knobs and Dials—larger, easier to control and better looking.
2. Filament Control Switch—snaps filaments on and off.
3. Jack—Allows you to plug in with head phones on three tubes. When tuned in, just pull the plug and you are switched to the loud speaker.
4. Elimination of Binding Posts on Front Panel—By removing the binding posts to the rear, the beauty of the set is greatly enhanced.
5. Sockets—The old white porcelain sockets are replaced with black compound sockets which are just as efficient and better looking.
6. Condenser—The New Molded Crosley Condenser made of a specially prepared compound will out-perform any condenser on the market.
7. Multistat—Allows use of all makes of tubes. (Now a feature of the standard Model X.)

Of course the regular Model X will be continued at $55.

CROSLEY BATTERY CABINET

That the unsightly batteries may be completely housed, a beautiful, wax finished mahogany cabinet is just being introduced to fit either the Crosley Model X or X-J.

This cabinet makes the set entirely self contained and greatly adds to its beauty.

Price, $16.00

CROSLEY
Better—Cost Less
RADIO PRODUCTS

New York Office — C. B. Cooper, 1803 Tribune Bldg., 154 Nassau St., Beekman 2061.
Boston Office—B. H. Smith, 755 Boylston St., Room 316.
Chicago Office—1311 Steger Bldg., 28 E. Jackson Blvd., R. A. Stemm, Mgr.
Philadelphia Office—J. H. Lyte, 65 North 63rd St.
St. Louis Office—Robert W. Bennett Co., 1326 Syndicate Trust Bldg.

Write for descriptive pamphlet
For sale everywhere by good dealers

CROSLEY MANUFACTURING CO.
916 Alfred Street **Cincinnati**

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RHAMSTINE*

Electric Soldering Iron

For Home or Laboratory

Specially designed for radio fans and experimenters. Attractively finished in nickel; heating element Nichrome resistance wire; soldering tip, when worn can be quickly and cheaply replaced. Use with either D.C. or A.C. Guaranteed one year. And like all Rhamstine products quality is combined with low price.

$2.50

Postpaid
Complete with 6 ft. cord, two-piece plug and self-fluxing solder.

You've always wanted an electric soldering iron; you need one for radio work, and here's your opportunity to get one specially adapted to the purpose. The Rhamstine* name guarantees quality and satisfaction.

Send $2.50 and we'll send it postpaid; or if you prefer, we'll send it Parcel Post, collect.

J. THOS. RHAMSTINE,* 2162 E. Larned St., Detroit, Mich.

Maker of Radio Products

41 W. 43rd St. New York City

Haynes-Griffin

New York's Largest Radio Store

A MAN IN NEW YORK

OWNING one of the best and most expensive sets made, lived within a few blocks of the powerful broadcast central WJZ Station at Aeolian Hall. He found it impossible to secure programs from any of the eight other active broadcasting stations in New York without continual interference from WJZ. He bought a

HAYNES SELECTOR

TRADE-MARK

"A New and Perfected Wave Trap"

Designed by A. J. Haynes, Originator of the Haynes Circuit

***Complete in Cabinet Postpaid* $8.50**

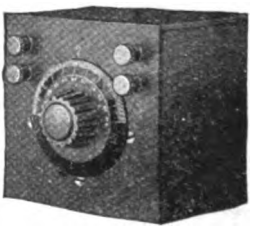
His interference troubles were solved. One simple adjustment of the Haynes Selector, and WJZ was shut out as completely as though that station never existed.

You or any other fan can do the same thing regardless of what broadcasting station is causing your trouble. The Haynes Selector is the final solution of all your interference troubles.

Special Filter Coil—The secret of the Haynes Selector lies in the special filter coil, never before used in any wave trap. The interfering station is quickly and entirely trapped out ***without slightest loss in signal strength of station you wish to hear.***

Can Be Used with Any Radio Set—You can connect the Haynes Selector with your receiving set in an instant's time. Two or more Haynes Selectors may be used in series and all local stations completely eliminated. You can then work through to long distance with an unparalleled degree of selectivity.

Send 2c Stamp for Leaflet—Our four-page illustrated leaflet giving in complete detail the many uses of the Haynes Selector, hook-up, diagrams and directions for use. We will be glad to mail these leaflets to any reader of Popular Radio upon the receipt of a 2c stamp.



Haynes Selector in Cabinet

HAYNES-GRIFFIN RADIO SERVICE, Inc. **41 W. 43rd St. New York City**

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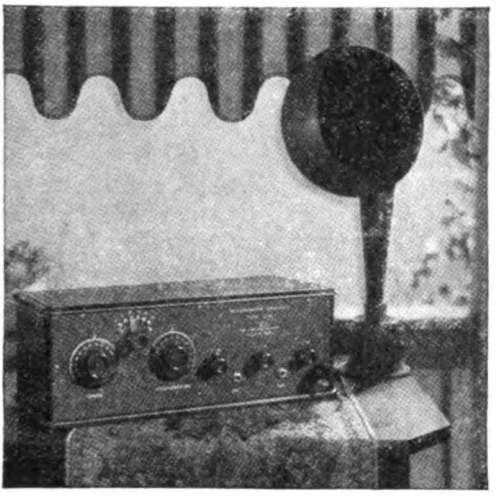

The New Tuska Popular No. 225

Regenerative Receiving Set, $75 without tubes, batteries, or loud speaker. Licensed under Armstrong Patent No. 1,113,149. Special circular 15-C sent on request.

Like a good old reliable friend

YOU turn to your Tuska radio set with perfect faith that it is always ready to be called upon. There is no fussing or coaxing—no apologies for its shortcomings. Year after year you can count upon this reliability of performance. New models will come, as in pianos and fine motor cars. But few will discard the old and buy the new for the sake of minor refinements. The Tuska set represents the highest point in radio development to-day; you can buy it for the future with confidence.

The Tuska is the ideal set for busy people who want the thrills of radio without the tinkering. It is simple to operate. You turn two dials, listen, and select the exact program you want from the dozens which fill the air. Nothing is forced upon you by the limitations of your set—every broadcasting station within hundreds of miles is within the call of your Tuska. A letter from Prince Albert, Saskatchewan, Canada, says, "We have tuned in clearly over 100 stations, and most of them are more than 1000 miles away."

Tuska sets are built under the personal direction of C. D. Tuska, a nationally known radio pioneer and builder of fine apparatus. For a dozen years Mr. Tuska has been keenly critical of all radio parts and sets bearing his name. As a result, the Tuska seal is recognized as a guarantee of the most thorough New England craftsmanship—and there is no better.

We will gladly send you the name of a near-by dealer who can show you the Tuska.

THE C. D. TUSKA CO., Hartford, Conn.

First to hear across the sea

A Tuska Receiving Set was the first to receive foreign amateur trans-Atlantic code during the international tests.

TUSKA TRADE MARK RADIO

Tuska distance records

During 12 years that Tuska Radio Apparatus has been in use, we have accumulated records of long distance radio reception that have never been surpassed.

TUSKA RADIO

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Biggest dollar's worth in RADIO

JUST OUT

Compiled by
HARRY F. DART, B.S.E.E.
Formerly with the Western Electric Co., and U.S. Army Instructor of Radio
Technically edited by
F. H. DOANE

THE greatest book on Radio ever written. Price only $1. Filled with sound, practical, tested information for every radio fan, from beginner to hard-boiled owl. Written, compiled and edited by radio experts of national reputation.

You may dip into this I. C. S. Radio Handbook at random, or hunt up special information you want, or read it right through. Starts with simple explanations of Radio phenomena and leads you along gently until you can understand the most technical diagram. Hundreds of suggestions for getting more pleasure out of Radio. Will save you from wasting money on things that won't work.

New—Authoritative—Complete

562 PAGES

Every page tells you something useful. And there are 562 pages! More than 150 illustrations and diagrams! Note this partial list of contents:

Different types of receiving and sending hook-ups, electrical terms, condensers, oscillating circuits, coupled circuits, induction coils, antenna systems, electric batteries, generators and motors, protective devices, crystal detectors, arc generators, transmitters, filters, wavemeters, radio experiments, International and Morse codes, commercial receiving sets, tables and data, radio transmitting and broadcasting stations (with call letters), Radio License Regulations, etc.

Send $1 to-day and get this 562-page I. C. S. Radio Handbook before you spend another cent on parts. Money back if not satisfied.

MAIL THE COUPON TO-DAY

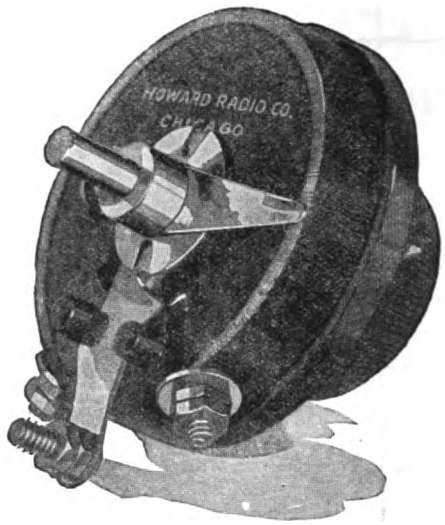
International Correspondence Schools
Box 8253
Scranton, Penna.

I enclose One Dollar. Please send me—postpaid—the 562-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

Name.....

Address.....

Money back if not satisfied



The New Howard Potentiometer 400 Ohms

The newest member of the nationally known Howard line of Rheostats and Potentiometers.

It is practically impossible to obtain satisfactory results with radio frequency amplifier sets unless the potential on the grids is under positive control.

The new Howard Potentiometer, 400 ohms resistance, gives the finest and closest control yet obtained.

This new Potentiometer, on account of its unusual close control, is desirable for adjusting the plate voltage of gas-content detector tubes.

HOWARD POTENTIOMETER

400 ohms (new)	**$2.00**
200 ohms	**1.50**

HOWARD RHEOSTATS

6¾ ohms plain	**$1.10**
6¾ ohms with micrometer adjustment	**1.50**
25 ohms plain	**1.10**
40 ohms plain	**1.10**

Howard Multi-terminal receiver plug. Instant connection—for six pairs of head phones—in series—series parallel—or parallel. Price $2.00.

Ask your dealer, or if he can't supply, write us, giving his name. Jobbers write for discounts.

HOWARD RADIO COMPANY

4246 N. Western Ave. Chicago

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There's Magic in the Air

THE night has a thousand voices. You can sit at home in your easy chair and hear the news and songs and music of a hundred cities when you own a Paragon Three-Circuit Receiver.

Pluck from the air the music to meet your mood; grand opera or jazz, chorus or orchestration; organ recital or church service. Listen, play by play, to the big athletic contests, lectures, speeches; to weather, crop and market reports; to the bed-time stories for the youngsters.

PARAGON

Reg. U.S. Pat. Off.

RADIO PRODUCTS

With a Paragon Receiver you get what you want when you want it—complete messages and clear music from the station you tune in on. Until you have listened in with a Paragon three-circuit Receiver, you cannot guess the real pleasure and fascination of radio.

Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

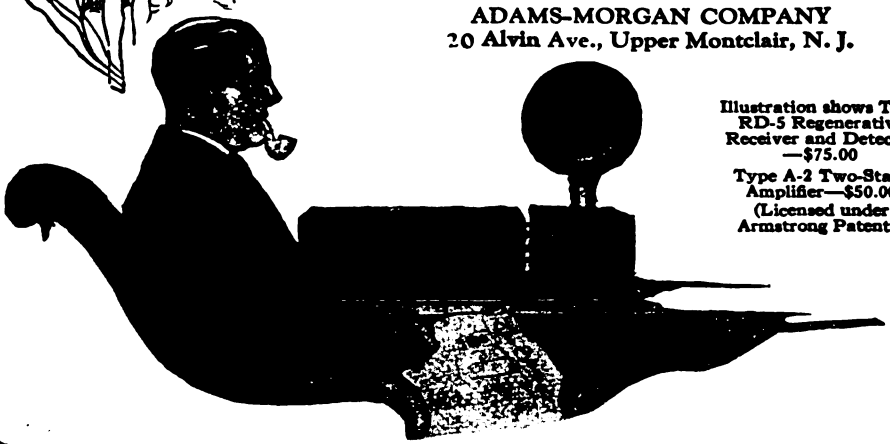

Illustration shows Type RD-5 Regenerative Receiver and Detector —$75.00

Type A-2 Two-Stage Amplifier—$50.00

(Licensed under Armstrong Patents)

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The Story of Service

BEFORE beginning the "Story of Service" let us study some of the definitions of the word "Service." Among them we find, "Act or means of supplying some general demand"—"That which promotes interest or happiness"—"Duty done."

Our goal is to make the above definitions synonomous with the "*SERVICE RADIO CO.*" Our "duty" is not "done" unless we "supply some general demand" and "promote interest or happiness."

The Story of Service Begins Next Month

SERVICE RADIO

is establishing new records in loud, clear reception from distant stations; makes summer radio more dependable and winter radio a revelation. Reception of distant stations through local stations—no outside wires! The Radio which combines beauty, ease of control, clarity of voice and music, distant reception and SERVICE. Compare with *any*, then decide.

Dealer's list appearing soon.
Write for "The Story of Service"

This is a TELEFORCE product.

SERVICE RADIO COMPANY

Dept. D
4727 Montgomery Ave.
Cincinnati, Ohio

H&H Radio Material

Nutmeg Brand

Based on 30 Years' Manufacturing and Electrical Development-Work

NUTMEG Brand covers a complete line of Radio Material and Apparatus. We carefully handle orders direct where the goods are not sold locally.

If your dealer cannot supply you, send us his name and address and secure, in return, a photo of an excellent one-step dry cell hook-up—*free.*

Specials:

W 300	6 Ohm Rheostats	$ .85
W 299	30 Ohm Rheostats	.85
W 298	6 Ohm Rheostats	1.00
W 297	6 Ohm Rheostats, with Vernier Dial Control, *at an introductory price*	1.25

Write for valuable informative circular

THE HART & HEGEMAN MFG. CO.
HARTFORD, CONN.

We Offer Cash for Your Spare Time

MAIL the little coupon today. It will mean money to you.

For every subscription to POPULAR RADIO, that you send us, we will reward you liberally in cash commissions and bonuses.

Many of your friends and acquaintances will be glad to subscribe to POPULAR RADIO when they learn that the price is going up and that they can save a dollar by subscribing now, through you.

Mail the coupon for full particulars and a sample copy.

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9 East 40th Street, New York City

Please tell me how I can make money in my spare time taking subscriptions to POPULAR RADIO. Send along a sample copy for me to work with; also other necessary supplies.

NAME .....

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The Singer –ALIVE– in your home!

MUSIC MASTER yields the actual, *living* voice of the vocalist—not an imitation or interpretation.

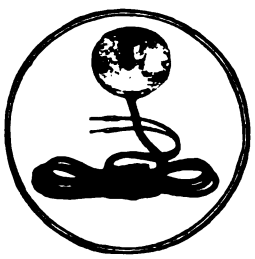
You hear the true timbre of the singer's tones, each expression of individuality, every nuance of personality—with the nicely balanced support of the orchestra or piano as it follows the artist.

MUSIC MASTER, the voice of Radio, and the "Stradivarius of Reproducers," is a marvel of clearness. It does not twist radio tones, but conveys them to you faithfully—exactly as produced by the artist at the instant.

Hear MUSIC MASTER talk for itself at your radio dealer's. Make comparisons. Assure yourself that it has no equal.

JOBBERS and DEALERS: Write now for full description of the entire GERACO Line and prices.

14-in. Home Model, $30
21-in. Concert Model, $35



Geraco Phonograph Attachment

Makes an effective loud-speaker out of any Victrola or Columbia Phonograph, $10 complete.

General Radio Corporation
Makers and Distributors of High-Grade Radio Apparatus
PHILADELPHIA
S. W. Cor. 10th and Cherry Streets
CHICAGO PITTSBURGH
Dealers Everywhere

Music Master
RADIO REPRODUCER

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Announcing—
A New
Burgess "B" Battery
Vertical Type

"A Laboratory Product"

THE engineers of the Burgess Laboratories have designed a new "B" Battery. When we use the term 'new' we are referring only to the shape, for it is vertical rather than flat as is the case of the standard Burgess "B" Batteries.

It was designed to meet a definite desire and almost an actual necessity arising through the widespread tendency to improve the appearance and convenience of home receiving sets by means of neater or more compact assembly of equipment.

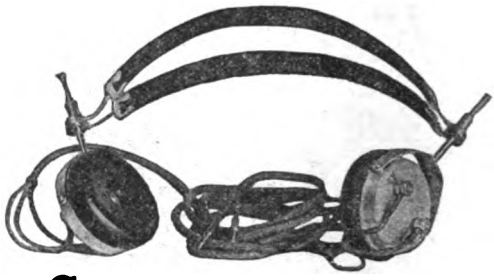
This new vertical "B" type battery saves half the floor space of the standard "B" battery. Because it stands vertically and is about the same height, it may be combined with a No. 6 Dry Battery if that type is used for the "A" or filament circuit. In the usual style of cabinet this vertical "B" battery may be slipped behind the equipment, leaving the terminals exposed at the top for convenient connections.

The Burgess Battery Company is responsible for many of the vital improvements found in present-day batteries, and this new vertical "B" Battery is recommended to you with every confidence that it will please you in every particular —power, silence, long life, convenience and absolute dependability.

BURGESS BATTERY COMPANY
Engineers—DRY BATTERIES—Manufacturers
Flashlight—Radio—Ignition—Telephone
General Sales Office: Harris Trust Bldg., Chicago
Laboratories and Works: Madison, Wisconsin
Branches:
New York Boston Washington St. Paul Kansas City New Orleans
In Canada: General Offices and Works, Niagara Falls, Ontario
Branches: Toronto Montreal Winnipeg St. John
"Ask Any Radio Engineer"

BURGESS
RADIO BATTERIES

3000 ohms $9.00 **2200 ohms $7.50** **2000 ohms $6.50**



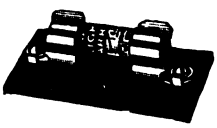
Super Sensitive Phones

The Teleradio head sets accurately reproduce the faintest signals on either crystal or tube receivers and bring in voice or music with wonderful tonal quality.

Equally satisfactory for local or long distance work.

They are designed and built on sound engineering principles and the construction is so sturdy that they will stand up under the hardest usage.

Teleradio Engineering Corp.
484 Broome Street, New York City



LIGHTNING ARRESTER
Approved by the National Board of Fire Underwriters
Price $1.00
Rheostat (30 ohms) $1.00

Teleradio
(TRADE-MARK)

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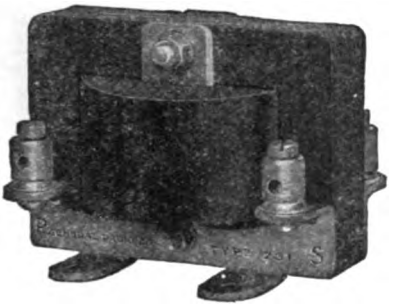
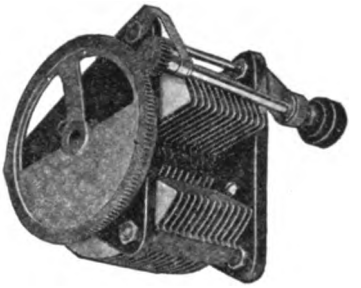
If you're building a Set—

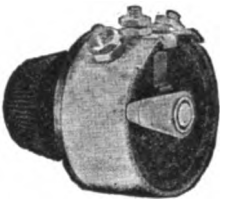


Type 231

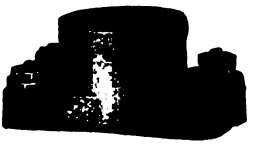


Type 247

Here are the essentials!



Type 301



Type 299

1. A quality Condenser—type 247—fitted with reduction gearing for fine capacity adjustment:

2. A Rheostat (or Potentiometer)—type 301—designed especially for UV-199 and 201A tubes:

3. A UV-199 Tube Socket, ruggedly built of molded Bakelite, with phosphor bronze springs:

4. And the well known General Radio Co. Amplifying Transformer giving maximum amplification without distortion.

All of these are guaranteed by the General Radio Company.

For dependability and results build your set around these essentials.

Ask for Bulletin 914U. It contains our complete line of receiving equipment.

Prices:

Type 247 Variable Geared Condenser	$3.25 to $7.25
Type 301 Rheostat 10 or 30 Ohms	$1.25
Type 301 Potentiometer 200 Ohms	$1.25
Type 299 Vacuum Tube Socket	$0.75
Type 231 Amplifying Transformer	$5.00

General Radio Company

Manufacturers of Electrical and Radio Laboratory Apparatus

Massachusetts Avenue and Windsor Street
CAMBRIDGE MASSACHUSETTS

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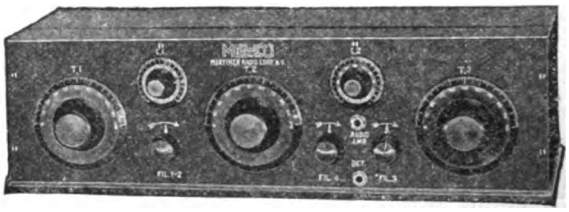
MELCO MEANS



REAL RADIO PERFORMANCE

New Principle of Tuned Radio Frequency Gives Remarkable Results

with the

MELCO-SUPREME

The Radio-Frequency Amplifying Receiver that—

Price Only $125

Operates with merely a 10 FT. WIRE.

Offers exceptional CLARITY without the slightest loss of tone quality.

Assures unusual program SELECTIVITY through its single tuning adjustment.

Affords real LONG DISTANCE by covering all Broadcasting ranges from 175 to 750 Meters.

Complete knock-down parts for Melco-Supreme including drilled engraved Bakelite panel and solid mahogany cabinet

PRICE $60

Mr. Lawrence Cockaday in his article on Tuned Radio-Frequency Amplification in the August "POPULAR RADIO" describes in minute detail the Acmedyne Circuit as employed in the Melco-Supreme

We also manufacture a complete line of parts under the AMSCO Brand. Write for our literature illustrating and describing our entire line of quality apparatus.

AMSCO PRODUCTS, Inc.

Broome and Lafayette Streets Dept. P.R. **New York City**

Enjoy leadership everywhere because they deliver the *maximum* results for a *minimum* expenditure—consistent with high grade materials, expert workmanship and correctness of design.

A most comprehensive line—Grid Condensers to finished Receiving Sets. Each a thoroughbred—all described in new literature. Handled by the best dealers from coast to coast.

VARIOCOUPLERS—FOUR STYLES . $3.50 to $8.00	INDUCTANCE TAP SWITCH $1.50
FAMOUS NEW YORK VARIABLE CONDENSERS — 11 plate $1.50 — 23 plate $2.00 — 43 plate $3.00—3 plate Vernier $1.25	VERNIER CONDENSERS 1.00
HIGH GRADE VARIOMETERS 3.50	MICA FIXED CONDENSERS — ALL CAPACITIES.
AUDIO FREQUENCY AMPLIFYING TRANSFORMER 4.00	SINGLE TUBE UNWIRED RECEIVER 18.00
NEW TUNED RADIO FREQUENCY TRANSFORMER 4.00	ENTERTAIN-A-PHONE RECEIVER, COMPRISING TUNER, DETECTOR AND TWO STAGE AMPLIFIER 50.00
	TWO STAGE AMPLIFIER—OPEN TYPE ... 18.00

NEW YORK COIL CO. 338-340 Pearl Street New York City, N. Y.

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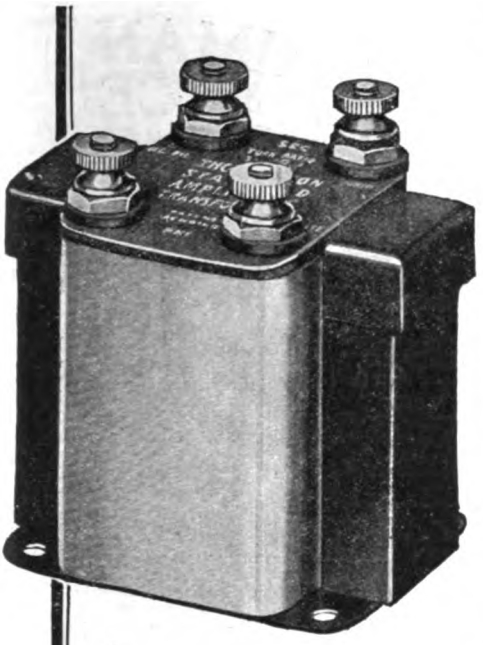

The New

THORDARSON

Super Transformer

More than a quarter of a century has been devoted by Thordarson engineers to the design and development of power transformers ranging in size from the smallest bell ringer to the first 1,000,000 volt transformer the world ever saw.

That knowledge and practical experience has been intelligently devoted to devising an Audio Frequency Amplifying Transformer that would produce the greatest volume consistent with *true tone quality.*

Here it is—its specifications and efficiency under all atmospheric conditions and over all audible signals, ranging from 100 to 7,000 cycles have been tested and endorsed by the foremost radio engineers in the United States. Thousands of these new amplifying transformers are daily furnishing the means to greater pleasure and entertainment to discriminating radio amateurs and experimentors.

Developed and manufactured entirely by Thordarson engineers in the Thordarson plant

It is not merely an assembly of bought coils, core iron, etc., as is the case of most audio frequency transformers in the market.

Core is made of .007 highest grade silicon steel, No. 36 gauge, the cross section of which measures ¾ inch—twice that of the usual type transformer. Coil is *square layer wound* of No. 40 wire to fit the square core. The winding process and machinery were designed and developed exclusively by Thordarson.

The basic principle and construction of this new Thordarson product are scientifically, electrically, and mechanically correct. Exhaustive tests and experiments have proved conclusively that:

1. Core losses are reduced to a minimum.
2. Over-saturation of the core is eliminated.
3. When in use the resistance of the plate circuit of one tube and the resistance of the grid circuit in the following tube are balanced to a degree heretofore unequaled.
4. The received energy is increased sufficiently to actuate loud speaking devices without distorting the incoming signal.
5. The volume produced is as great as *pure tone quality reproduction will permit.*

The new Thordarson amplifyer is the choice not only of thousands of amateurs and experimenters, but an increasing number of leading receiving set manufacturers now specify Thordarson Transformers as standard equipment.

Make your own test

Words nor pictures nor specifications alone can do justice nor prove the superiority of Thordarson products. Let your own ears guide you in your comparison.

SOLD AT ALL GOOD DEALERS

PRICE, MOUNTED ONLY

6 to 1 ratio transformer . $4.50
(with Red Label)

3½ to 1 ratio transformer 4.00
(with Blue Label)

THORDARSON
ELECTRIC MFG. CO.

Huron and Kingsbury Streets, Chicago

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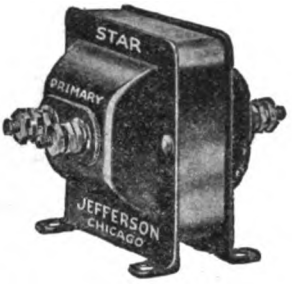


JEFFERSON

Amplifying Transformers

have gained an enviable reputation for audibility and amplifying power. In tens of thousands of receiving sets they are insuring 100% amplification—increased range, super-sensitivity, and the elimination of howling and distortion.

This positive preference rests on the unmistakable superiorities of design and operation which make Jefferson Amplifiers the choice of discriminating radioists.

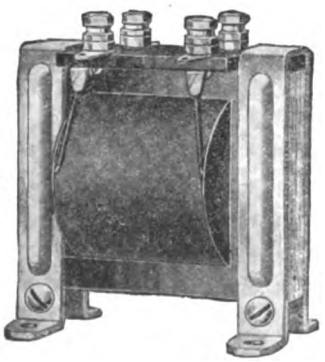
FIVE JEFFERSON TYPES

The five Jefferson types meet the demand for an audio-frequency transformer for every requirement. In this assortment you are sure to find the transformer which will make your set super-sensitive, and enable you to tune in distant stations with ease, and freedom from distortion.

Radio Bulletin Sent Free

Jefferson Electric Mfg. Co.

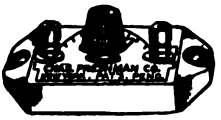
427 S. Green Street Chicago



FRESHMAN RESISTANCE LEAKS

The largest and most Complete line in the World

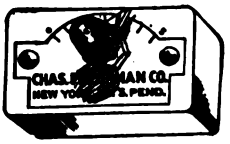
Our new construction of all types Variable Resistance leaks produces a product which we can now guarantee as being scientifically correct, mechanically perfect and built for unusual durability.



Every tube and every circuit requires a different leak resistance. You do not know what value is necessary until your circuit is tested. Freshman Variable Resistance leaks give an unbroken range of 180 degrees from zero to five megohms.

Base Mounting Type with either .00025 or .0005 Freshman Condenser **$1.00**

Without Condenser..... 75c



PANEL MOUNTING Freshman Variable Resistance Leaks

will enable you to get stations you have never heard before. Can be mounted on any panel in a few seconds. The latest and most essential part of an efficient tube set.

With either .00025 or .0005 Freshman Condenser **$1.00**

Without Condenser.....75c

FRESHMAN "FIX-O" Fixed Resistance Leak Combination —4 in One

Freshman Condenser .00025, Leak Mounting Price Freshman Resistance Leak, Safe-T Handle Complete **65c**

FRESHMAN FIXED Resistance Leak With Safe-T Handle

The only Resistance Leak using no carbon, graphite or lamp black. Guaranteed to remain *permanently constant*. Furnished in any value of Resistance from ¼ Megohm up **30c**

FRESHMAN NOISELESS Tested Mica Condenser and Leak Mounting

The Freshman Condenser is so designed that constant equal pressure is exerted over the entire area of the condenser plates and the mounting is part of the condenser itself, which makes this new product the only True and Perfect Leak Mounting on the market.

Combination Condenser .00025 and Leak Mounting... **40c**

All Freshman Products at your dealers—otherwise send purchase price and you will be supplied without further charge.

Also ask your dealer for our free diagrams of the Neutrodyne, Flewelling and Kaufman Circuits.

Chas. Freshman Co. Inc.

Radio Condenser Products

106 Seventh Avenue New York

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You Can Fill One of These Big-Pay Positions Waiting in Radio!

$2500 to $10,000 a Year

NO other training offers such opportunity for success as a Certified Radio-trician. Honor, power, position, wealth—all are easily possible for those who enter this great new profession NOW, while it is growing.

Now the Easiest Growing Business

Radio has jumped into the front rank of the world's great industries, yet it is only in its infancy. Its vast, amazing possibilities are as yet undiscovered in a large measure. And great as it is today, it will be a thousand times greater tomorrow! The man who gets into Radio today—who prepares NOW to grow up with this wonderful new science—will have a great share in its glorious future.

Master Radio at Home

To the ambitious man, Radio offers greater opportunities for success than any other profession or trade. It offers you a wonderful position, interesting work, and a fine salary. Radio spells SUCCESS.

The National Radio Institute, known the world over as the largest Radio Training Organization, will prepare you quickly in *your spare time at home* to qualify for the position you want. Hundreds of our graduates are today reaping big returns from their instructions. Some of them are radio inspectors and engineers. Others are in charge of land and sea stations. Still others are in charge of radio departments in stores or are in business for themselves.

Pick Out the Job You Want We Will Help You Get It

Brief list of the positions in the radio field today and the salaries paid.

Radio Mechanic, $1,500 to $4,000 a year.
Radio Inspector, $1,800 to $4,500 a year
Radio Salesman, $2,000 to $10,000 a year.
Radio Engineer, $3,500 a year and up
Radio Executives, up to $15,000 a year
Radio Instructor, $200 to $500 a month
Radio Draftsman, $7 to $15 a day
First Class Ship Operator, $105 a month, all expenses paid.
Second Class Ship Operator, $95 a month, all expenses paid.
Third Class Ship Operator $85 a month, all expenses paid.
Commercial Land Station Operator, $150 a month and up
Broadcasting Station Operator, $125 to $250 a month.

Big Money—Easy Work

Most of our graduates when they started our course, knew little or nothing about Radio. Yet, in a few short months, our instruction qualified them to earn big money as Certified Radio-tricians. The same instruction, the same help that brought quick success to these men, is now offered to you. You have the same opportunities, you have the same prospect they had. Take advantage of them. Get into Radio NOW. Grow up with it. Advance with it.

Send for FREE Book

We have just prepared a wonderful book which is filled with the latest information about

the wonderful opportunities in this newest and fastest growing profession. It will be sent to you absolutely FREE. Send for this book. It will tell you all about how we prepare you for, and help you to get or secure the wonderful positions open in this fascinating field. Mail coupon for this book NOW! National Radio Institute. Dept. 32-I, Washington, D. C.

National Radio Institute, Dept. 32-I, Washington, D. C.

Send me your wonderful book, "Your Opportunity in Radio" with full particulars about the opportunities in Radio, and how you will quickly train me in my spare time at home to become a Certified Radio-trician. Also tell me how your free Employment Service will help me to a position and particulars of your special short-time offer.

Name.....Age.....

Street.....

City.....State.....

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BUILD YOUR OWN HAZELTINE-NEUTRODYNE RECEIVER

With these FADA Neutrodyne Parts, one can successfully construct his own Neutrodyne circuit radio receiver

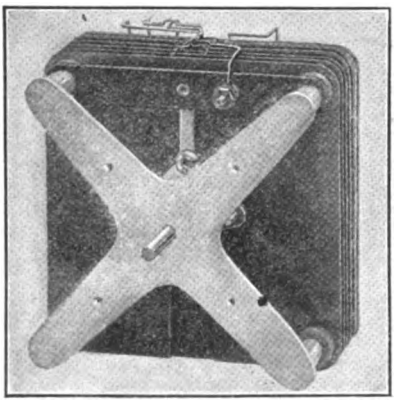
Use FADA Parts

The combination package pictured combines three FADA "Neutroformers," and two "Neutrodons" and a very complete booklet telling "How to Build Hazeltine Neutrodyne Receiver."

For only $25.00 you can purchase these essential FADA Neutrodyne Parts, and be assured of success with your home-made Neutrodyne circuit Receiver.

Extra copies of the 32-page "How to Build Hazeltine Neutrodyne Receiver" booklet will be sent for 50c.

F. A. D. ANDREA, INC.
1581-D Jerome Avenue, New York City



Write for FREE booklet on Radio Frequency Amplifiers by Lester L. Jones

Vario-transformers

Used in the

~~ACMEDYNE~~ TELOS

circuit are guaranteed to give the greatest radio frequency amplification and selectivity.

Telos Vario-transformers are the only practical devices for obtaining tuned radio frequency amplification in one unit. Type TC4 for wave length range of 180 to 610 meters.

DANZIGER-JONES, Inc.

145A Prince Street **New York City**

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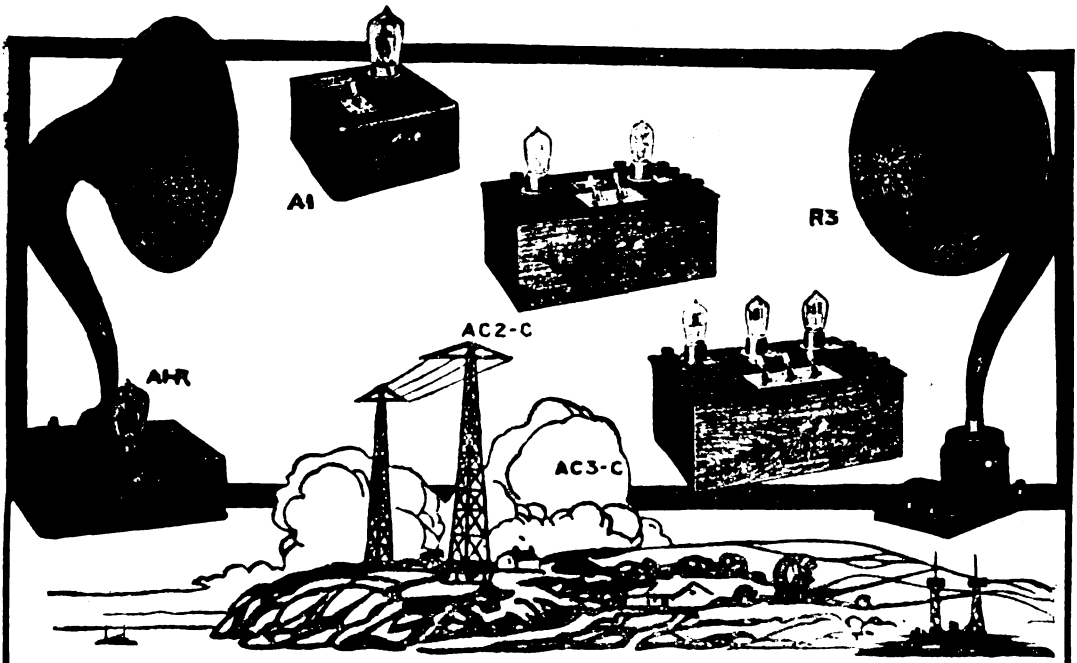

Radio Takes Another Step Forward

THE new Magnavox models (rapidly being distributed to the trade) extend and supplement the already famous Magnavox line, which now includes a Magnavox for every receiving set.

A brief summary of Magnavox products is given below:

Magnavox Reproducers

R-2 with 18-inch curvex horn. .	$60.00
R-3 with 14-inch curvex horn. .	35.00
M1 with 14-inch curvex horn; requires no battery for the field. .	35.00

Magnavox Combination Sets

A1-R consisting of Reproducer R3 and 1 stage of amplification. .	$59.00
A2-R consisting of Reproducer R3 and 2 stages of amplification. .	85.00
A1-M same as A1-R but with Reproducer M1	59.00
A2-M same as A2-R but with Reproducer M1	85.00

Magnavox Power Amplifiers

A1—new 1-stage Power Amplifier.	$27.50
AC-2-C—2-stage Power Amplifier.	55.00
AC-3-C—3-stage Power Amplifier.	75.00

Ask your dealer for demonstration. Interesting booklet will be sent on request.

THE MAGNAVOX COMPANY
Oakland, California
New York Office: 370 Seventh Avenue

MAGNAVOX PRODUCTS

The only complete line of Reproducers and Power Amplifiers

8-T

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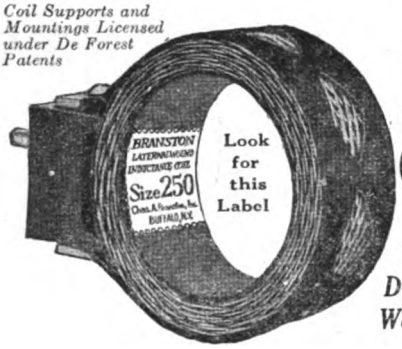
Coil Supports and Mountings Licensed under De Forest Patents



Insist on the Genuine

They are Duo-Lateral We call them

BRANSTON Lateral Wound Inductance Coils

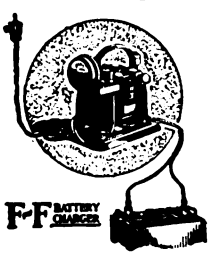
No other method of tuning has approached the wonderful flexibility of the Honeycomb Coil in changing to different wave lengths. If you are in doubt, ask your "Old Timer" radio friend why sets using Honeycomb Coils are better.

With Branston Honeycomb Coils you can get closer tuning, greater selectivity, greater range. Two outstanding features of the Branston Coils are—no dead end losses and ease of operation.

Send 2c in stamps for Series 1 "Hook-Up" Circular showing five good Honeycomb hook-ups and Catalog of famous Branston Radio materials. Write today giving your dealer's name. If he can't supply you, let us know.

Chas. A. Branston, Inc.
811 Main St. Buffalo, N. Y.
In Canada—Chas. A. Branston, Ltd. Toronto, Ont.

BRANSTON RADIO



$15.00

F. O. B. CLEVELAND

Type 6 charges 6 to 8 Volt storage battery from any 110 Volt 60 Cycle lamp socket at average rate of 6 amperes

Contactors *Can't* BURN or STICK

They also permit a desirably high charging current that makes for quick and easy storage battery charging.

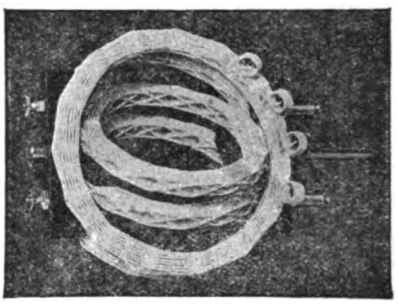
Buy from your dealer. There's a type for every need. If he cannot supply you, write for literature or enclose remittance covering express or postal charges on 9 lbs.

Dealers Write for Complete Details in Bulletin No. 44. It's Free!

The France Mfg. Co.

10344 Berea Road Cleveland, Ohio

Pioneer Manufacturers of Patented Battery Chargers



R. M. C. Diamond Weave Variocoupler

Wound to eliminate capacity and dielectric losses. Low distributed capacity—high inductance.

Panel mounting requires very small space; screw holes covered by 2" dial.

Adaptable to all circuits requiring variocoupler. Provided with seven taps, equally spaced, on primary. Bushed bearings.

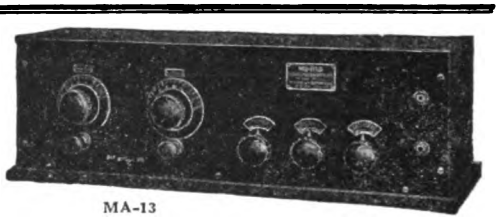
R. M. C. Variometer similar in construction. Gives extreme maximum and minimum values. Highest quality in material and workmanship.

Variocoupler..... **$4.25**
Variometer..... **4.25**

Write for catalog on other diamond weave coils, and Radio Frequency Transformer.

THE RADIO MANUFACTURING COMPANY of Springfield, Massachusetts

Dept. B 97 Dwight Street



MA-13

—of special interest to Radio Dealers!

One of Chicago's oldest and largest exclusive radio stores sold more Mu-Rad Receiving Sets in 1922–23 than all other types of Receivers combined!

Mu-Rad sells—and sells!

That fact has been repeatedly verified by our many other Mu-Rad dealers in the middle-west. Why not join them? Why not enjoy as they do the ***assured profits*** of good radio merchandise well advertised (see page 49 of this magazine)?

Write for a Mu-Rad Franchise

To get complete details of our special Mu-Rad proposition will not obligate you. Write also for a copy of our hand-book catalog of other profitable radio merchandise. Write today before someone else in your neighborhood gets exclusive Mu-Rad privileges.

Chicago Radio Apparatus Co.

Jobbers of Good Radio Merchandise

General Offices: 407 S. Dearborn Street, Chicago

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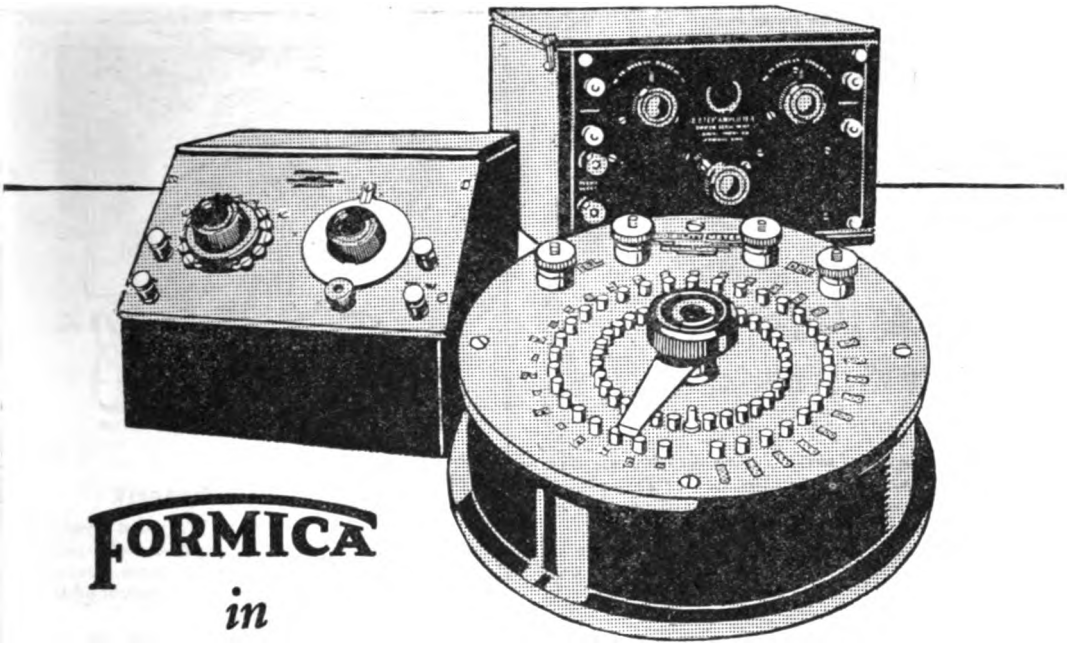

FORMICA
in
GENERAL RADIO *Apparatus*

THE General Radio Company, makers of precision instruments for use in radio and electrical work, is one of the oldest as well as the most consistent users of Formica.

The high quality of the General Radio product is assurance to amateurs and dealers everywhere that when they use Formica insulation, they are using the best material that the market affords.

Formica service is as good as the product. It supplies promptly a panel or tube of just the size that is wanted—no need to confine yourself to so-called standard sizes that some one else wants to sell.

THE FORMICA INSULATION COMPANY
4641 Spring Grove Ave., Cincinnati, Ohio

SALES OFFICES

50 Church Street . . New York, N. Y.
422 First Avenue . . . Pittsburgh, Pa.
1042 Granite Bldg., Rochester, N. Y.
415 Ohio Building . . . . . Toledo, Ohio
1210 Arch Street . . . . . Philadelphia, Pa.
1819 Lyndale Ave., S. Minneapolis, Minn.
Sheldon Building . . . . San Francisco, Cal.
Whitney Central Bldg. . . . . New Orleans.
414 Finance Bldg. . . Cleveland, Ohio
9 S. Clinton Street . . . Chicago, Ill.
313 Title Building . . Baltimore, Md.
47 King Street . . . . Toronto, Ontario

FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

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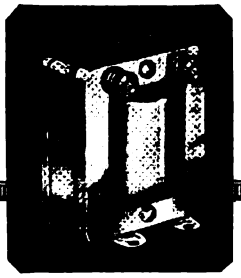
$4 NO MORE



$4 EVERY WHERE

NATIONAL
AUDIO
TRANSFORMERS
Are Giving
PERFECT SATISFACTION

on thousands of sets. Use them on your set—with any type of tube. Better Transformers are not made. Highest grade materials and workmanship. Approved by experts everywhere. At your dealer. If not, order direct, mentioning his name. Dealers: Write for sales proposition.

NATIONAL

NATIONAL TRANSFORMER MFG. CO.
154 Whiting Street, Dept. 911, Chicago, Illinois

Grewol
THE PERMANENT DETECTOR

Fixed Adjustment

The Grewol is adjusted on the most sensitive spot on the crystal and *fixed*—proof against vibration and jar. Protected from dust and moisture by glass enclosure. Grewol adds to the efficiency of reception.

Packed in individual carton with instructions **$2.00**

Write for Booklet

RANDEL WIRELESS COMPANY
4 Central Ave. Newark, N. J.

Add WARREN RADIO LOOP
these Advantages to Your Set

Sharper Tuning
One tuning adjustment—no others needed.

Directional
Receives signals strongest.

Selective
Picks out just the station you want to hear.

Portable
Small, light, compact. Ideal for portable and mobile sets.

Wider Range of Frequencies
on single coil.

Small re-radiative effect. Fine for regenerative circuit.

Type A-737 (300-700 meters) 6 inches square—non-directional.....$10
Type A-7236 (175-1000 meters) 6 inches square—non-directional.....$12
Type S-2537 (300-700 meters) 18 inches square—directional.....$20
Type BL-2520 (200-18,000 meters) with honeycomb coil mounting. 18 inches square—directional.....$25

Send for Bulletin 1-102

V-DE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.

Natural Re-PRODUCTION
Atlas
AMPLITONE
LOUD SPEAKER

Blast and distortion conquered! Double-diaphragm faithfully re-PRODUCES the full range of musical sounds. Adjustable to varying receiving conditions.

Hear the difference when your dealer demonstrates the Atlas Amplitone. **$25**
Write for Booklet "B"

Letters from Users Requested

What have you accomplished with your Atlas Amplitone? Tell us about it.

Multiple Electric Products Co. Inc.
RADIO DIVISION
ORANGE ST., NEWARK, N.J.

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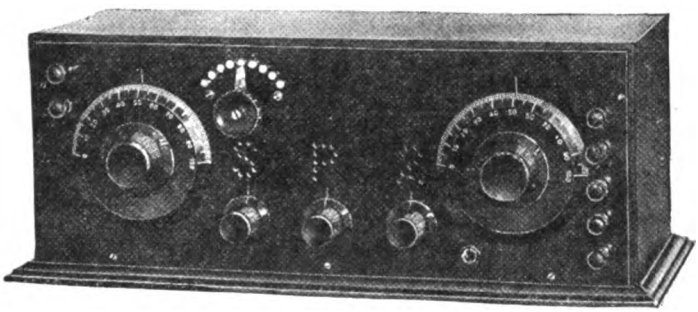
S P 2



MR. DEALER—are you looking for a receiver that will reduce your service expenses to practically nothing; will stay sold; can be sold on what it will do and not on talks about its superior circuit and incorporation of this or that; a receiving set that can be sold on an unconditional guarantee; is efficient, sound and thorough in every respect? THEN YOU ARE INTERESTED IN THE S. P. 2 RECEIVER. Your letter head will bring you our proposition in detail together with complete catalogue.

Catalogue 101 A—*A complete catalogue of radio equipment and valuable radio information mailed to the "radio fan" on receipt of 10 cents in stamps.*

PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Avenue **Pittsburgh, Pa.**

SP2

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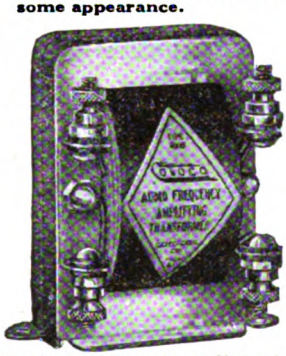
Cotoco

TRADE MARK REG. U.S. PAT. OFF.

"Built First to Last"

The Audio Frequency Transformer that Combines ALL the Essentials for Complete Satisfaction.

Cotoco Transformers afford all the ideal features listed below and besides are of unusually handsome appearance.



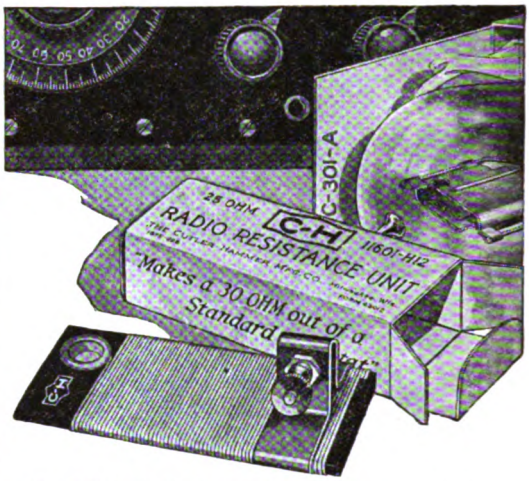
1. **High Amplification.**
2. **Minimum Distortion.**
3. **Low Interstage Linkage.**
4. **Convenient Mounting.**
5. **Compactness.**

Sold by Reliable Dealers Everywhere.

COTO-COIL CO.

Providence, R. I.

Pacific Coast Branch, 329 Union League Bldg., Los Angeles



The C-H Radio Resistance Unit attaches instantly to your present rheostats for control of the "A" type tubes. Saves the cost of new rheostats, as well as the trouble of redrilling your panel. Buy one with each new tube and enjoy better reception tonight. Price 25c at dealers everywhere.

THE CUTLER-HAMMER MFG. CO.
Milwaukee, Wisconsin

C-H

More than one-half million C-H Radio Rheostats now in use.

CUTLER-HAMMER

INSTRUMENT MAKERS

DEPENDABLE TESCO **PRODUCTS**

SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured

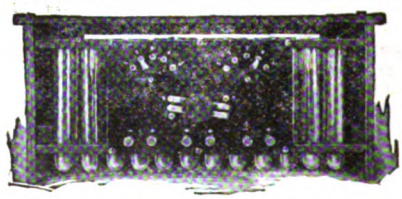
FREE FAMOUS TESCO RADIO Crystal Set (Shown in Cut)

To introduce the wonderful T-B-H radio headset we will give absolutely free of charge, the most efficient crystal receiver on the market.

SEND NO MONEY

Just pay postman $5.00 plus postage. Money refunded if not absolutely satisfied.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.



100 Volt Panel (new type)

KICO

Storage "B" Batteries give long service at low cost

Alkaline type, will not sulphate or buckle. Life unlimited. Not harmed by short-circuiting, overcharging, or standing idle. Panel switches afford single cell variations. Easily re-charged from any 110-volt A.C. line by means of small home rectifier. One charge lasts three to six months in detector plate circuit.

Prices without rectifier:		Plain	(With Panels)
16 cell	22 volt	$5.50	
24 cell	32 volt	$7.25	$11.75
36 cell	48 volt	$9.50	$14.00
50 cell	68 volt	$12.50	$17.00
78 cell	100 volt	$17.50	$22.50
108 cell	145 volt	$23.50	$28.50
Unmounted rectifier		$1.00	
Mounted rectifier		$2.50	

SATISFACTION GUARANTEED

All batteries are sold with the privilege of receiving your money back if not satisfied within a 30 day trial. Write for full information on "A" and "B" Batteries.

KIMLEY ELECTRIC COMPANY, Inc.
2667 MAIN STREET BUFFALO, N. Y.

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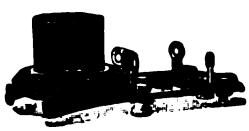
EISEMANN

The design of Head Phones is simple, practical and correct. May be worn for long periods without discomfort. Extraordinarily sensitive and reproduce sound with unusual clarity. Give complete satisfaction.

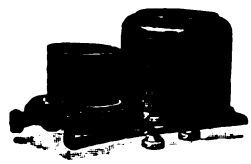
Hard-drawn aluminum plates and rugged construction throughout insure continuous functioning of Condenser. The vernier plate is controlled by the knob nested within control bar.

The Variocoupler is complete in every detail. No additional parts are required to complete the assembly. A tap-switch is carried *inside* the rotor and forms an integral part of the unit.

The finest grade insulating materials are used in the Variometer. Forms are exceptionally light in weight; the losses usually encountered through large masses of insulation being thereby reduced.



A combination Detector Unit, comprised of socket, rheostat and spring clips for holding grid leak and grid condenser. Socket terminals are connected to binding posts at rear.



The Amplifier Unit combines a socket, rheostat and audio frequency transformer—on a single mounting bracket. All leads are short and direct. Mounting is extremely simple.

Aluminum panels, in several stock sizes, are offered for use with Eisemann parts. The panels are completely drilled, and ready for use. No shielding is required; the metal panel itself acting as a perfect capacity shield.

Catalogue on request.

EISEMANN MAGNETO CORPORATION

William N. Shaw, *President*

BROOKLYN, N. Y.

DETROIT CHICAGO SAN FRANCISCO

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makes perfect panels

No other material known is so "professionally smart"—as beautiful—

bakelite-dilecto!!

(A Laminated Phenolic Condensation Product)

Bakelite-Dilecto (XX grade) makes any home-made hook-up look like a "store set." Finished a sleek, everlasting black.

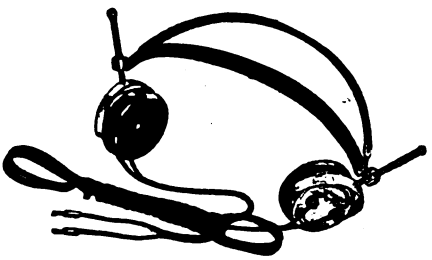
Astonishingly hard and tough; yet machinable.

Guaranteed highest dielectric strength.

Have your electrical dealer get B D X X cut to the exact size you require.

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware
Dealer Service from:
New York, 233 Broadway
Pittsburgh, 301 Fifth Ave.
Chicago, 332 S. Michigan Ave.
San Francisco, 75 Fremont St.
Los Angeles, 411 S. Main St.
Seattle, 1041 Sixth Ave., S.

AMPL-TONE PHONES



2200 Ohms—$6.00

AT LAST, the public may have these EXCELLENT Headsets at a popular price. Positively the equal of the expensive phones, for beauty, comfort, tone and durability.

Money back guarantee protects you. "Wonderful value," "Equal to $12.00 phones" and other testimonials on file.

Write for special prices for a limited period

DEALERS: Get in on our special advertising and extreme discounts. One sample for $3.25 cash.

C. M. FRENCH MFG. CO.
SEYMOUR, CONN

for
PURE TONE QUALITY
and MAXIMUM VOLUME
The AMERTRAN
AUDIO TRANSFORMER

Price $7

Ask your electrical dealer, or sent carriage charges collect. (Wt. 1 lb.)

is recognized by the Radio Profession as the
STANDARD
OF
EXCELLENCE

All you need to know about this audio transformer is to be found in Circular 1005 which will gladly be mailed upon request.

American Transformer Company
Designers and builders of radio transformers for over 20 years.
175 Emmet St., Newark, N. J.

YELLOWTIP
MICROMETER ADJUSTING
CRYSTAL DETECTOR
Increases the Efficiency of Your Crystal Set

Finer tuning, clearest possible reception, constant adjustment until you wish to change, then—"A Twist of the Wrist—It's Set." Excellent for reflex and other circuits. *Write for folder and name of your nearest dealer.* **$2**

Wholesale Radio Equipment Company
Exclusive Factory Representatives
36 William Street Newark, N. J.
Dealers and Jobbers—Write for Attractive Proposition

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Radio Catalogue Free—

Write us a post card—

and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete set for $32.50 equalling sets at $60.00 elsewhere—a $23.50 set that under favorable conditions has a radius of 500 miles and more.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

Headquarters for Radio

Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

Write to the house nearest you. Address Dept. 38-R

Chicago Kansas City St. Paul Portland, Ore. Fort Worth

Montgomery Ward & Co.

The Oldest Mail Order House is Today the Most Progressive

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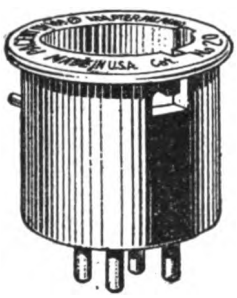
PACENT ADAPTER

For U. V. 199 Tubes



A thorough quality Pacent product. Contact and Insulation perfect. Cannot short circuit. Satisfactory for radio frequency circuits. At this price, the logical choice of all radio users. Catalog No. 20

50c

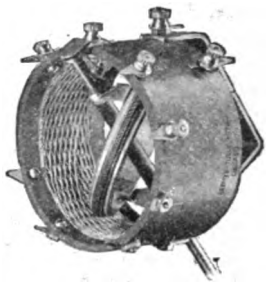
Send for Pacent bulletins P-9

Don't Improvise—"Pacentize"

Pacent Electric Co., Inc., 22 Park Place, New York, N. Y.

Pacent

RADIO ESSENTIALS



The "B-T" Universal Vernier Tuner

Is 1st—The ***best Reinartz Tuner*** available.

2nd—Will give better control and maximum results on any single circuit Regenerative, any of the Ultra-Audion or practically any of the Reflex circuits, including Hazletine.

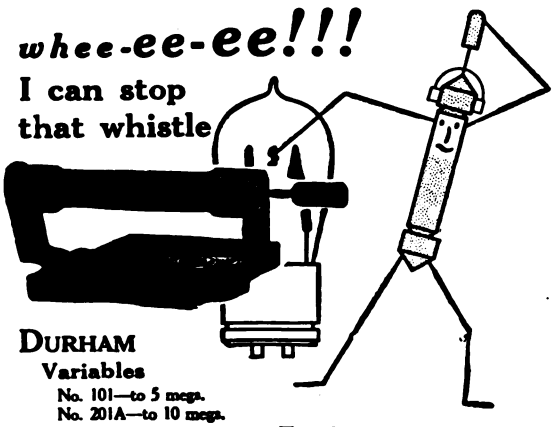
It's the biggest new thing in Radio. Free Photo Diagrams of various circuits make assembly easy. Endless combinations are possible. No more ideal part for the experimenter is made. See your dealer first. If he does not yet carry it, send his name and address and $5.00.

BREMER-TULLY MFG. CO.

534 So. Canal Street, Chicago, Illinois

whee-ee-ee!!!

I can stop that whistle



DURHAM

Variables

No. 101—to 5 megs.
No. 201A—to 10 megs.

DUBILIER

Condensers

.00025 mfd.
.00050 mfd.

There's a combination for your tubes

For that maddening moment when you hear "This is - is station —" A touch or a pull of the DURHAM plunger brings the call in clear.

Your dealer has it for $1.10 complete

Durham & Co., 1936 Market St., Philadelphia

Dealers:—Every-time a tube squeals there's a call for Durham-Dubilier. *Answer that call!*

The ***Standard***

"All-American" Transformers

Radio and Audio Frequency

now being used in radio sets manufactured by leaders in the industry.

Radio Frequency Transformer

Audio Frequency Transformer

These manufacturers have expended a great deal of time and money in the testing of transformers to give best results. They can not afford to take chances. Their preference of "All-American" Transformers is your guide to real satisfaction.

Ask your dealer to show you "All-American" Transformers.

Free Offer Book of Hook-Ups containing twenty-five successful circuits. Send 2c stamp to cover postage.

RAULAND MFG. CO.

200 No. Jefferson St., Chicago, Ill.

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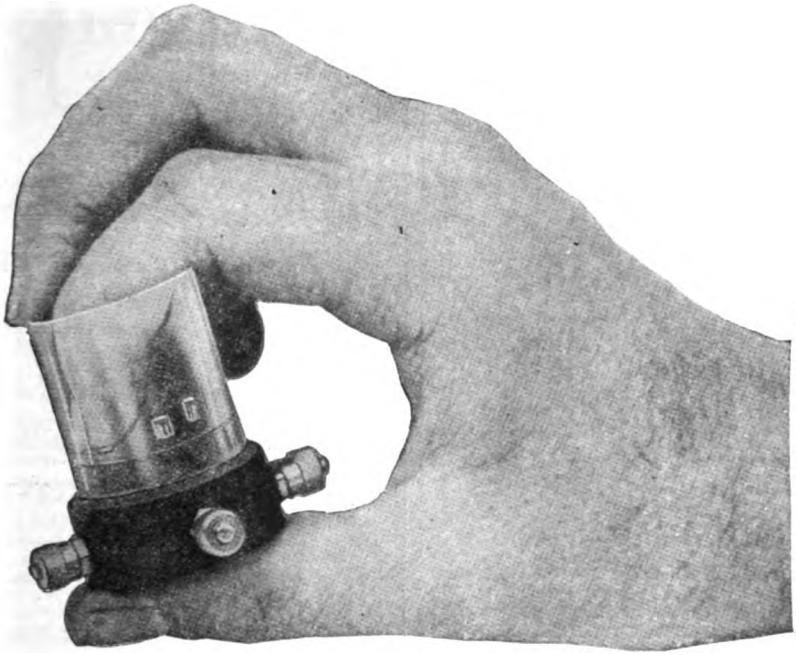
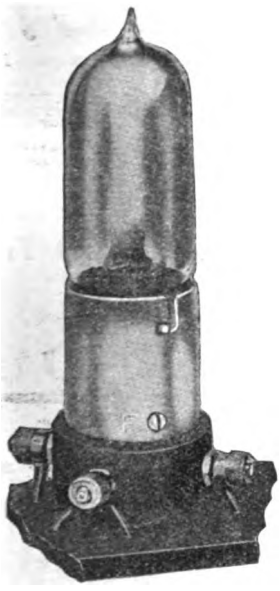


Firm Pressure Exists Here!



Cushion Mounting

The most valuable socket is the one that gives you the surest connection with your tube terminals.

That is the

MARCO 199 SOCKET

PRICE 75c

Manufactured by

MARTIN-COPELAND CO.

PROVIDENCE, R. I., U. S. A.

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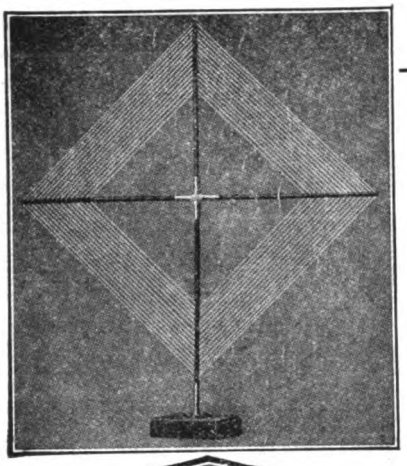


HARTMAN

LOOP AERIAL $10.00

Light—Substantial—Efficient—Directional
4 inch molded dial-detachable base.

Hartman loops stay taut and true.

33½ in. wide—36½ in. high—15 turns—4 in. dial.

Write for bulletins on Hartman Radio parts.

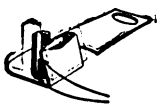
THE HARTMAN ELECTRICAL MFG. CO.
Mansfield, Ohio

Na-ald Special Socket No. 499

It's the contact that counts

A careful examination will show that each contact in Na-ald sockets and adapters is of a wiping nature on a broad surface, and of sufficient tension, and so designed that tension is permanent, no matter how often the bulbs may be removed and how much the connecting prongs in the tubes vary.

It is little realized that sockets are being sold which, owing to faulty choice or control of material, develop current leakage from plate to grid that rob many otherwise well-made sets of their efficiency. Na-ald sockets in their design avoid all these troubles.



De Luxe Contact

Na-ald De Luxe No. 400

NA-ALD SOCKETS

No. 499 Socket, 199 tubes	$0.50
No. 429, Adapter, 199 tubes	.75
No. 400, De Luxe, 200 tubes	.75
No. 401, Small Space, 200 tubes	.35
No. 411, W. D. 11 Tube	.75
No. 450, Two in One, W. D. 11 or 200 Tube	.50

Booklet with diagram of Haseltine's Neutrodyne Circuit and other selected circuits, packed with each Na-ald product.

Alden Manufacturing Co.

Manufacturers of Sockets for Every Tube and Requirement

Dept. C 52 Willow St.

Springfield, Mass.

CABLE ADDRESS: ALDENCO

RADIO PRODUCTS NA-ALD

"UNITED"

Radio Instruments Will Multiply the Joy of Your Radio Evenings

Our new million dollar plant with its unequalled equipment of precision tools and one staff of trained radio experts have enabled us to develop condensers and transformers which offer

1—Finer tuning, under more perfect control.

2—Clearer reception, from any distance,

3—Welcome freedom from discordant noises.

"United" Audio-frequency Amplifying Transformer Magnetically shielded, Ratio 5 to 1. Price $4.50.

"United" Variable Condensers, with new Vernier. Dial Adjuster

43 plate $6.50	5 plate $5.00
23 plate 6.00	3 plate 4.75
11 plate 5.50	Postpaid

Try your Dealer First. If he does not carry the line, remit to and give us his name and address.

UNITED MFG. & DISTRIBUT'G CO.
9705 Cottage Grove Ave.
Chicago, Ill.
New York Office:
50 Church St., New York, N.Y.
San Francisco Office:
709 Mission St.
San Francisco, Cal.

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static?

John A. Burrichter, 207 East Ohio Street, Indianapolis, Indiana, writes:

"My set is about ten blocks from one of the local stations and when they started broadcasting, it meant that ended everything for the evening. After your Wave Trap was installed, they were tuned out completely.

Had expected with the approach of warm weather to take down my set until next fall, but while other local 'Listeners In' are almost entirely cut off by STATIC, I am enjoying the programs just as much as in the cold months.

Have covered distances that heretofore have been impossible and really consider the Wave Trap the greatest invention since radio."

The Original Wave Filter $8.50 Prepaid

use FERBEND Wave Trap TRADE MARK

PATENT APPLIED FOR

21 E. SOUTH WATER ST. CHICAGO

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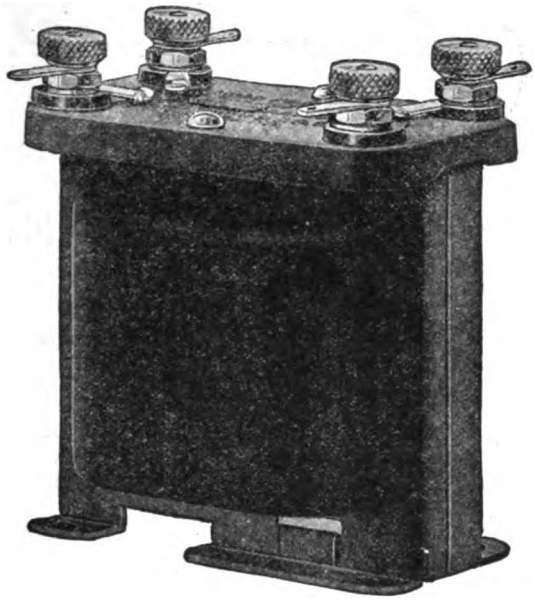
Volume! Clarity!! Delight!!!

With Correct Hook-up— Proper Inductance and Capacity —and Good Detection



You Are Assured a New and Better Amplification— Maximum Volume— Minimum Distortion

With Kellogg Shielded Type Transformers

Correct audio frequency amplification is important in the satisfactory operation of loud speakers. Proper amplification [with KELLOGG transformers] results in a clear reproduction with minimum distortion and maximum volume.

Kellogg transformers are designed to overcome any defects of existing types and to furnish the very best of amplification.

They are built complete by the Kellogg Company, using magnet wire with the very best insulation, and of exactly the correct number of turns. The metal case is heavily enameled in maroon with a Kellogg Bakelite connecting rack. The laminated cores of silicon steel are correctly proportioned and shaped for the most effective electrical field.

The primary and secondary binding posts are accessibly placed at the top of the transformers, and clearly marked so that there need be no error in connection.

Every Kellogg transformer is thoroughly tested before leaving our plant and we guarantee the purchaser a product of exceptional efficiency.

No. 501—Ratio 4½ to 1—$4.50 each
No. 502—Ratio 3 to 1— 4.50 each

Kellogg Switchboard & Supply Company

Adams and Aberdeen Streets · Chicago

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"How I Located My Trouble"

A Massachusetts radio enthusiast tells of a happy discovery that finally solved his difficulties.

"I COULDN'T figure out what was wrong with my radio set," states a Fitchburg business man whose experience is interesting because it shows how one simple little adjustment will sometimes make such an amazing improvement in results.

"I had erected my antenna in just the right way, had connected up my different parts with the greatest care, had added improvements that were designed to bring my apparatus to the highest possible perfection," he continues.

"I spent a good many hours talking over my problems with dealers and experts. I followed one suggestion after another. But still the same old trouble!"

Do You Have This Trouble?

"In spite of all my efforts, when I wanted to hear some particularly interesting broadcasting program, other stations kept breaking in; I found difficulty in getting long distance points; and intermittent squeals, whistles and howls would persist, no matter how I tuned or adjusted my dials.

"I was pretty nearly convinced I'd have to get some high-priced installation man to come out to my home and set me right, when purely by chance I happened to pick up a copy of POPULAR RADIO—and thumbing through its pages I found the very answer to my problems!

"There in black and white, diagrammed and explained, was a simple, practical suggestion that turned the trick for me."

The One Best Way to Get Results

Many other radio enthusiasts, too, who want to get the **most** out of their sets have found in POPULAR RADIO many an idea and practical suggestion that has made a world of difference in their enjoyment of this fascinating pastime, and saved them hours of experiment and costly error.

If you don't already *subscribe* to POPULAR RADIO, don't miss this opportunity of getting the magazine regularly at your permanent address.

By subscribing now, you save a dollar. POPULAR RADIO soon goes to $3 a year, so if you act promptly you get a year's subscription for only $2.

Your Questions Answered *FREE!*

Then, too, as a regular subscriber, any questions you wish to ask of the Technical Editor will be answered **free of charge.** This is one of the most valuable features of POPULAR RADIO'S service, and is the same service for which non-subscribers pay 50 cents for each question asked, and they say it's worth many times what they pay. *Yet you can get this same added service absolutely free.*

The Coupon Entitles You to This Service

Simply fill out and mail the attached coupon today and your subscription will start with the very next issue. If you have some problem to put up to our Technical Editor now, send in your question with the coupon and he will be glad to straighten you out. This is a privilege to which all subscribers are entitled, and we want you to take full advantage of it.

But do not delay sending in your subscription. Get POPULAR RADIO regularly each month and don't risk missing any of its scores of helpful and practical suggestions.

POPULAR RADIO, Dept. 93,
9 East 40th Street, New York City

Please put me down for a year's subscription to POPULAR RADIO, beginning with the October issue. I am enclosing $2 in full payment which also entitles me to free use of your Question and Answer Department for a full year.

Name .....

Address .....

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(No extra for Canada. Foreign countries 25 cents postage extra.)

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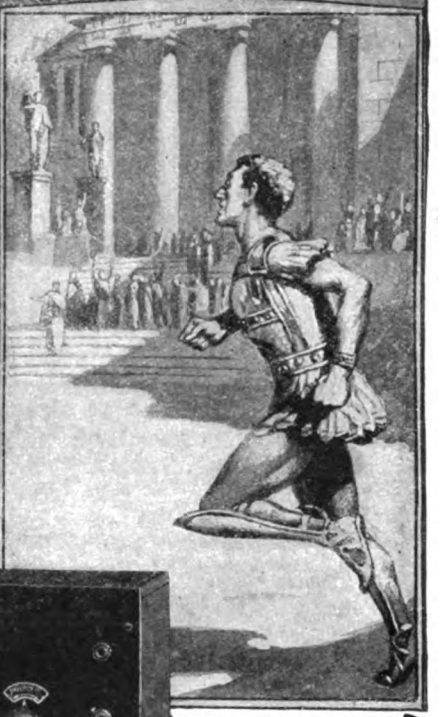
MU-RAD RECEIVERS

The Ultimate in Radio Reception



To bring the news of the Greek victory over the Persians at Marathon a runner was dispatched to Athens, 24.85 miles away. Reaching the market place, he cried out, "Rejoice, we conquer!" and fell dead.

The New Star in the Radio World

EVERY ADVANCE of civilization has depended upon the progress of communication. From the Athenian runner, to the instantaneous transmission of intelligence by radio is a triumph of science. As one Athenian runner was preferred over another for speed and accuracy, so today MU-RAD Receivers are chosen for the most perfect reception of radio broadcasting. Four thousand miles and more are spanned with delightful ease by the MU-RAD Receiver. Uses only a two-foot loop aerial. Utmost efficiency with utter simplicity. Guaranteed conservatively for 1000 miles reception. *Be satisfied with nothing less than the ultimate attainment of the radio science — a Mu-Rad Receiver.*

WRITE FOR LITERATURE

MU-RAD LABORATORIES, INC.

809 FIFTH AVE. ASBURY PARK, NEW JERSEY

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A Great Money-Saving Opportunity!

Glance over this big list of magazine clubbing offers that POPULAR RADIO has arranged for your benefit. Here is your chance to get almost any magazine you want—and by ordering now with a year's subscription to POPULAR RADIO you get *both* magazines at rock bottom prices that cannot be duplicated later on.

FOR a limited time only, we offer this broad selection of leading magazines at very special bargain prices with a year's subscription to POPULAR RADIO.

If you are already a subscriber to POPULAR RADIO, these special club offers allow you the privilege of renewing or extending your subscription at a great saving of money. If you are not already a subscriber, don't delay taking advantage of this opportunity to get POPULAR RADIO and *your choice* of these other leading magazines at *greatly reduced prices.*

As announced on the "Pages with the Editor" of this issue, the subscription price of POPULAR RADIO will soon be advanced from $2 to $3 a year. Yet all of these magazine combinations are figured at a price for *each* magazine far lower than even the present subscription prices.

There is hardly a home where one of these magazines does not already bring pleasure and profit to *some* member of the household. The magazine requirements of your whole family for the coming year can be taken care of *now*, by simply checking the club offer you want and mailing the coupon to us with your remittance.

But do not delay. Our special arrangement with these other publishers is for a few weeks only. After that, the prices on these clubs will be advanced. And by acting *now* you safeguard yourself, in addition, against POPULAR RADIO's raise in price, which will soon be effective.

Your Favorite Magazines at Lowest Bargain Prices!

McCall's **Popular Radio** $3.60 Newsstand Value for..... **$2.25**	**Modern Priscilla** **Popular Radio** $4.90 Value For..... **$3.00**
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Or You Can Make Up Your Own Club of POPULAR RADIO With:

Boy's Magazine	$3.60 val., for...	$2.60
Century Magazine	8.40 val., for...	6.25
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Judge (52 issues)	7.60 val., for...	6.25
Movie Weekly	7.40 val., for...	6.25
Physical Culture	5.40 val., for...	4.50
Popular Science Monthly	5.40 val., for...	4.25
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Scribner's	6.60 val., for...	5.25
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POPULAR RADIO, Dept. 91,
9 East 40th Street, New York City.

Enclosed is $..... Please see that yearly subscriptions are at once entered in my name for each of the magazines I have checked in the special bargain club list at the right.

Name.....

Street and Number.....

City.....State.....

(If not a NEW subscription, please mark R after the name of the magazine, to indicate RENEWAL.)

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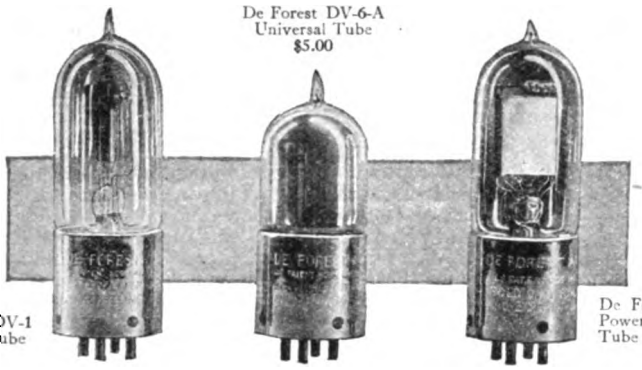


The More You Know About Radio the More You Rely on De Forest

Without Lee De Forest's discovery of the vacuum tube there would be no radio today. All radio broadcasting, all radio receiving by means of tube sets, rests on De Forest patents.

De Forest has been a pioneer in radio since 1900 and De Forest is a pioneer today. That is the reason for the great success of the De Forest Reflex Radiophone. That is the reason for the success of the new De Forest tubes—DV-1 Dry Cell Tube, DV-6-A Universal Tube, DV-2 Wet Cell Power Amplifier Tube.

If you want a radio receiving set with a range on indoor loop of from 1,500 to 3,000 miles, depending on atmospheric conditions; if you want simplicity of control, clear reception without distortion and without extraneous noise; if you want operation on either wet or dry cells—see the De Forest Reflex Radiophones at the De Forest agent's today.

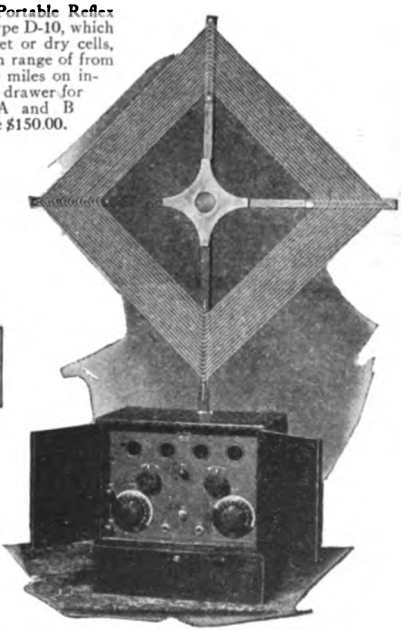
The D-7-A Reflex Radiophone is a three-tube set at $125.00; the D-10 Portable Reflex has a drawer in its cabinet for dry batteries and is a four-tube set at $150.00. No matter what you pay, you can't get greater radio satisfaction.

Whether you buy your set complete, or build your own from the laboratory tested De Forest parts, you can rely on De Forest, the greatest name in Radio.

De Forest Radio Tel. & Tel. Co.

Dept. P, Jersey City, N. J.
Western Sales Division
5680-12th Street, Detroit, Mich

De Forest Portable Reflex Radiophone type D-10, which operates on wet or dry cells, has a reception range of from 1,500 to 3,000 miles on indoor loop; has drawer for all necessary A and B dry cells. Price $150.00.



Radio Catalogs Free

Send a postcard for De Forest's Free Radio Catalog with full details and prices on sets, tubes, and parts.

De Forest products are sold only through exclusive agents, direct to the public for your protection. The De Forest Company will be glad to hear from representative men in various communities who wish to become exclusive De Forest agents.

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REFLEX SUPERIORITY! RESULTS GUARANTEED!

Are you getting the best from your Reflex Set?

MPM
MILLION POINT MINERAL
THE WORLD'S GREATEST RADIO CRYSTAL

M. P. M. (MILLION POINT MINERAL) CRYSTAL

—tested and guaranteed—has proven itself the superior crystal for Reflex Reception. M. P. M. will not corrode or burn out; does not lose its sensitiveness; and clear, musical, economical reproduction is assured. Unsolicited testimonials show marvelous long-distance records, both with and without amplification. Ask your dealer for M. P. M., or send us 50 cents for two unmounted, or 70 cents for two mounted; and, in addition to crystals, we will send you diagram of a reflex circuit that we guarantee will give absolute satisfaction.

M. P. M. SALES CO., Dept. PR, 247 So. Central Ave., Los Angeles, Cal.

PAT. APP'D FOR

THE

TURN-IT

GRID-LEAK

Adjustable continuous range
¼ meg. to 2 megs.
Stays Put

FITS STANDARD MOUNTS
NO CARBON—NO GRAPHITE
NON-MICROPHONIC

A unique principle is employed which eliminates sliding or pressing contacts.

Improves any circuit, particularly of the Flewelling Type.

PRICE 75c

at your dealer or

CHARLES E. BONINE

(If ordering direct, give name and address of dealer)

Franklin Tr. Bldg., . Phila., Pa.

ATWATER KENT

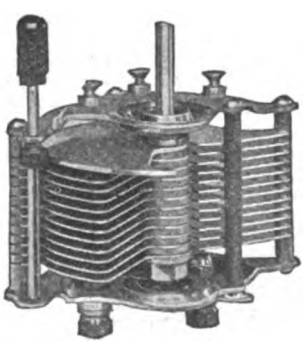
RADIO

A 2-stage Amplifier unit was submerged in water for several hours, after which it was put in a circuit and tested for reception with perfect results.

Send for the illustrated folder

ATWATER KENT MFG. COMPANY
4933 Stenton Ave. *Radio Dept.* Philadelphia

Makers of
THE WORLD'S HIGHEST GRADE IGNITION
STARTING AND LIGHTING



VARIABLE VERNIER CONDENSERS

POINTS OF SUPERIORITY

1. Stator plates instead of being loosely fitted are pressed into slots assuring *perfect electrical contact.* 2. Correct capacities. No over-rating. 3. Rigid reinforced aluminum end plates. 4. Rotor and Stator plates of logarithmic curve. 5. Insulating designed to reduce losses to Minimum. 6. Patented vernier arrangement eliminating body capacity. 7. Accurate and correct spacing of special spring aluminum plates. 8. Extremely low dielectric losses. 9. Friction adjustment on rotor shaft, assuring perfect positive and permanent tuning adjustment. 10. Independent Vernier Control. Vernier does not rotate with main rotor plates.

Type G. 13, .0002 M. F., $2.75—Type H. 23, .0005 M. F., $3.25—Type J. 43, .001 M. F., $3.50.

Sold by All Leading Electric Firms and Radio Dealers.
Jobbers, Dealers and Write for Discounts and Set Manufacturers.

MIGNON ELECT. MFG. CORP., Rochester, N. Y.

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Something New in Radio

Hear Your Local Concert Perfectly Through a LOUD SPEAKER With This One Tube Set, Operated By Dry Cells

Etherphone *The* SUPER SENSITIVE RADIO RECEIVER

The latest development in the radio field. An instrument with all the advantages of multi-tube sets, requiring but a single UV-201 Tube, operated by dry cells giving the perfection of reproduction heretofore only obtainable in the simple crystal sets. **GUARANTEES RECEPTION OF FROM 20 TO 30 MILES THROUGH A LOUD SPEAKER. STATIONS FROM 200 TO 800 MILES AWAY CAN BE HEARD CLEARLY THROUGH A HEADSET.** In it the tube does double duty, first amplifying the incoming signals at radio frequencies, after which they are rectified, or detected, by a sensitive crystal, and then passed back through the same tube at audio frequencies. Wonderfully compact, simple to operate and offered at a price much lower than that of multi-bulb sets.

DEALERS

Write for attractive proposition.

Price of Instrument Alone $45

Price Complete Including Loud Speaker Ready to Listen in $75

ECONOMY Four ordinary dry cells will give service of 100 to 125 hours. Or three or four blocks of B batteries will last six months or a year.

RANGE In tests we have consistently heard (during summer months) Stations: WLAG—Minneapolis; WMC—Memphis; WDAP—Chicago; WOC—Davenport; WGY—Schenectady, and frequently WBAP—Fort Worth; WFAA—Dallas; WSB—Atlanta.

VOLUME Equals that of a two or three tube set, easily operating a loud speaker on local broadcasts and at times on distant reception.

TONE QUALITY Attains perfection owing to the clearness obtained through its crystal detector.

PORTABILITY Easily carried when touring or camping; also ideal for use on a boat.

Write for Descriptive Folder. For Sale by Reputable Dealers, or if Not Carried in Stock, can be Ordered Direct from the—

Radio Apparatus Co. 40 West Montcalm St. Detroit, Michigan

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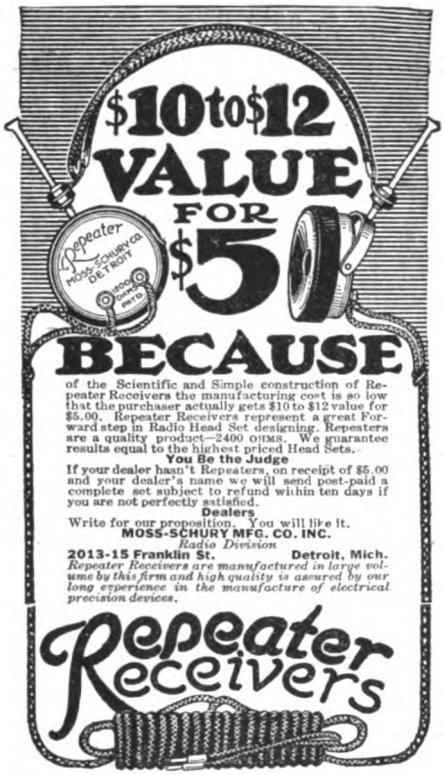
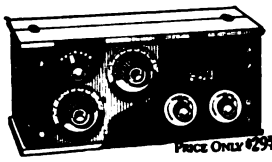

$10 to $12
VALUE
FOR
$5
BECAUSE
of the Scientific and Simple construction of Repeater Receivers the manufacturing cost is so low that the purchaser actually gets $10 to $12 value for $5.00. Repeater Receivers represent a great Forward step in Radio Head Set designing. Repeaters are a quality product—2400 ohms. We guarantee results equal to the highest priced Head Sets.
You Be the Judge
If your dealer hasn't Repeaters, on receipt of $5.00 and your dealer's name we will send post-paid a complete set subject to refund within ten days if you are not perfectly satisfied.
Dealers
Write for our proposition. You will like it.
MOSS-SCHURY MFG. CO. INC.
Radio Division
2013-15 Franklin St. Detroit, Mich.
Repeater Receivers are manufactured in large volume by this firm and high quality is assured by our long experience in the manufacture of electrical precision devices.
Repeater Receivers



MIRACO GETS 'EM 1500 MILES AWAY

At the low prices shown below you get the efficiency of sets costing three times as much.
These radio frequency receivers—pick up stations over 1,500 miles away under good conditions—everywhere.
Operate either on DRY CELLS or storage battery.
Cabinets of solid mahogany and workmanship the finest throughout. Order direct or send for bulletin.
Two tube outfit, as shown above, headphones only $29.50
Four tube outfit for loudspeaker or headphones $54.50

DEALERS AGENTS—write for proposition quickly—it's a winner.

THE MIDWEST RADIO COMPANY
812 Main Street Cincinnati, Ohio

For Long Distance Reception
ATHERTON
AUDIO-FREQUENCY TRANSFORMERS
Rank Absolutely Supreme

Powerful Amplification
Clear and Perfect Reproduction on All Wave Lengths

No Distortion nor Howling
No Resonant Peak

Designed to Meet the Characteristics of All Tubes

The Highest Grade Amplifying Transformer Manufactured
Unrestrictedly Guaranteed

RATIO 5 to 1
Recommended for 1st Stage.

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We Repair and Guarantee Them

Repairing the following tubes and many others
Vacubub Amplifiers and Detectors
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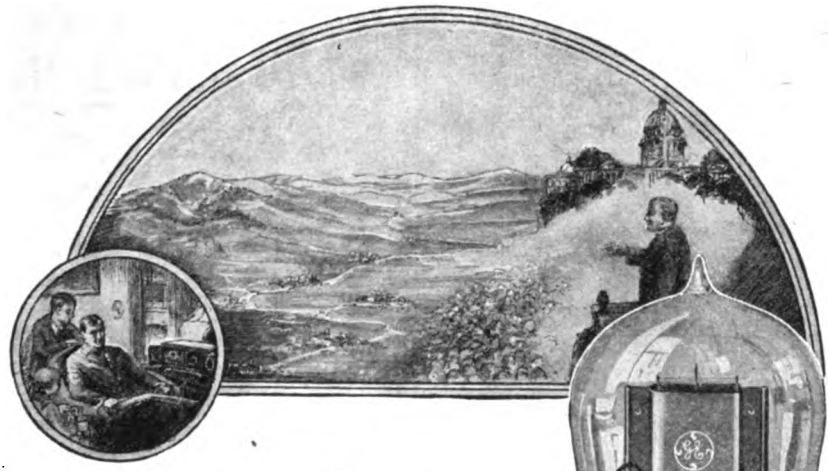

Carries Great Messages Around the World

THAT statement adequately expresses what is perhaps the greatest influence of radio in developing and bettering human fraternal interest, not only between the people of one community, of one country, of one state, or even a single nation, but between all nations and all peoples of the world.

Be these messages from government leaders—from the heads of the world's greatest educational institutions or from those who stand foremost in the arts of the world—they will serve to bring the human race into closer contact.

In the past ages great orators and writers, famous poets and musicians have swayed the destinies of nations, and have been instrumental in the rise and downfall of mighty empires.

In the future these same influences of similar great minds will, through radio, create a better understanding and a greater fraternal spirit between the people of the nations.

It is the vacuum tube that has made possible this broad and far reaching application of radio telephony, and that plays the most important part in the operation of your receiving set.

Cunningham Vacuum Tubes, standard for all makes of receiving sets—built by one of the world's largest manufacturers with unlimited resources—are the product of years of manufacturing experience and the creative genius of the engineers of that great scientific organization, the Research Laboratory of the General Electric Company.

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Special Base	
C- 12 — Similar to C-11 with standard base	$6.50

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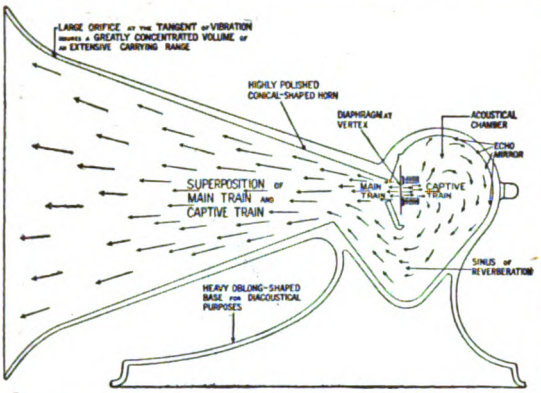

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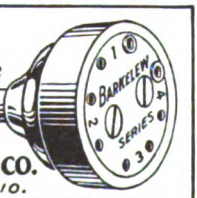

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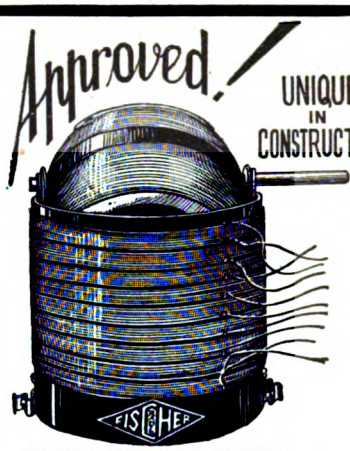

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Approved because it is scientifically unique in construction, because it makes a 1000 meters with ease, because it has a genuine bakelite stator and a kiln dried rotor, because it is bank wound, because each tap eats up its 100 meters neatly, because—but why write history? See for yourself.

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EASTERN COIL SETS

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COCKADAY CIRCUIT

The remarkable features which are making this circuit more popular each day are its simplicity of construction and control—wonderful selectivity—distance records clearness and loudness of reception, and the fact that all capacity squealing, interference, etc., are eliminated.

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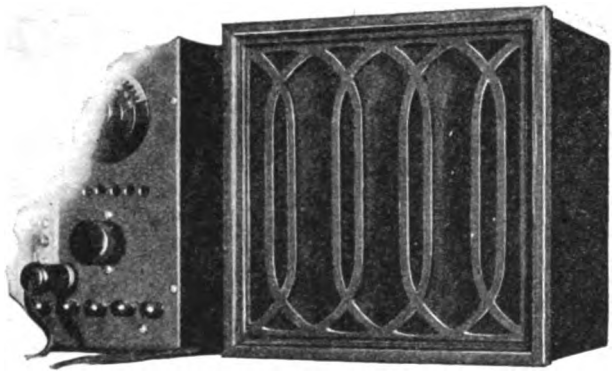
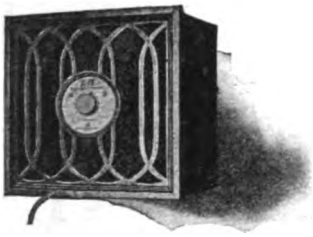
The new Timmons Talker with stationary magnet. The Gothic scroll design is the same as the adjustable type. Price $25.



A New Timmons Talker—With Stationary Magnet

—the adjustable type, too, has been made even better



The adjustable type which now has a grill of Gothic scroll design backed by a screen of light gold color. Price $35.

Note in the illustration how the lines of Timmons Talkers are in harmony with those of all radio sets—there's no jarring conflict of shapes.

Both Timmons Talkers are built around the principle of reflected tone—a scientific method of amplifying and then reamplifying music or the voice so that volume is attained without losing any of the fullness or roundness of either, and without forcing tubes.

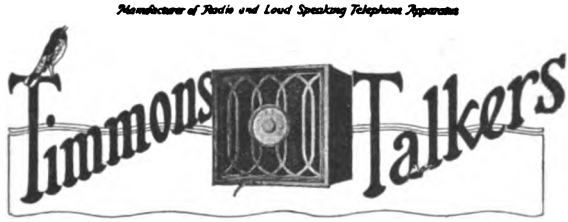
Reflected tone requires two horns. These are hidden from view behind a finely executed design of mahogany-finish Gothic scroll.

We make both horns of metal and coat them with a substance developed in our own laboratories.

We would really save money by using wooden horns. However, metal horns finished with this newly developed coating have a naturalness and richness which no wooden horn could ever equal.

—But let your dealer show you a Timmons Talker. He'll be glad to demonstrate both stationary and adjustable types. Also ask him for the Timmons Talker folder, "Volume Without Noise." If for any reason he does not have any of these folders handy, we'll send one at once.

J.S.TIMMONS
339 East Tulpehocken St.
Germantown, Phila., Pa.
Manufacturer of Radio and Loud Speaking Telephone Apparatus



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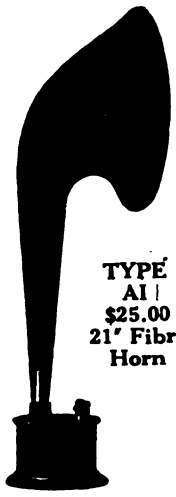

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Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

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$2.28

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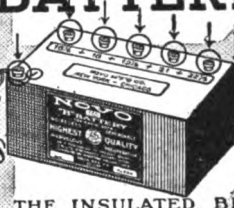

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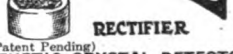

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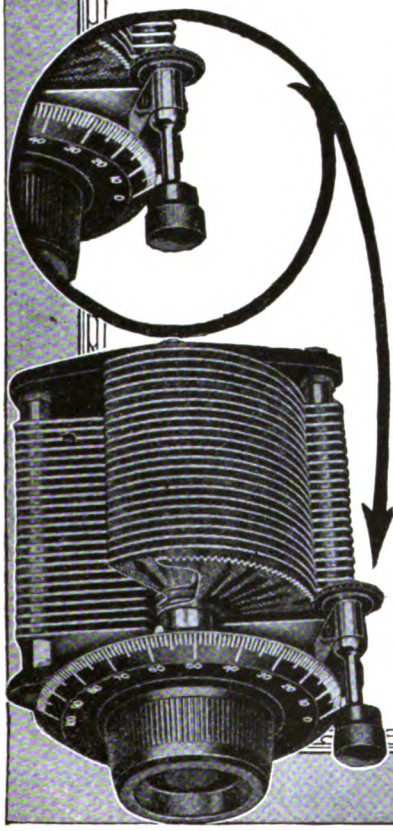
Radiant Variable Condensers exceed the standards of just "good condensers" by adding exclusive advantages which definitely establish these condensers as superior value. Warping of plates, which necessitated frequent realignment, was regarded as a necessary evil—until *Radiant Condensers* were made with permanently *FLAT*, non-warping plates. No readjustment needed during years of use. Prevention has replaced *correction* in *Radiant Condensers*.



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Since the purpose of the vernier adjustment on a condenser is superfine tuning—the importance of this improved vernier plate is evident at a glance. The vernier plate is geared to the adjusting knob as the parts of a watch are geared. Micrometer adjustment to the thousandth of an inch, with a slight, easy turn.

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—yet it will come to you without extra cost if you act at once!

TO our big family of POPULAR RADIO readers the addition of 56 more pages of reading matter in the November issue will be mighty welcome news.

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So there is only one thing to do. We must increase the thickness of the magazine! Now there will be no space limitations to prevent getting these articles quickly to our readers. "Month by month POPULAR RADIO is growing bigger and bigger."

The Same POPULAR RADIO *—only more of it!*

You'll be tickled with POPULAR RADIO these coming months. The same helpful, practical, interesting articles will continue. There will be more of them. New departments will be added. Don't take a chance on missing any of these bigger, better issues. Become a regular subscriber and get the magazine each month at your home.

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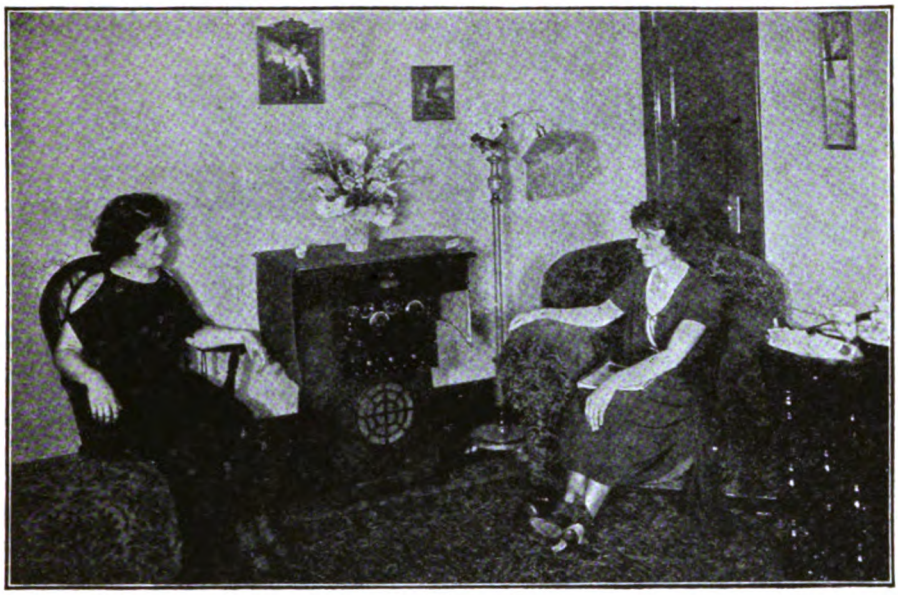

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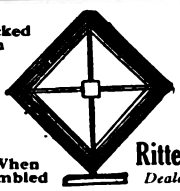

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Contents: Wire, binding posts, wood parts, instructions. By mail 10c extra.

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$31.50 in 2 Weeks

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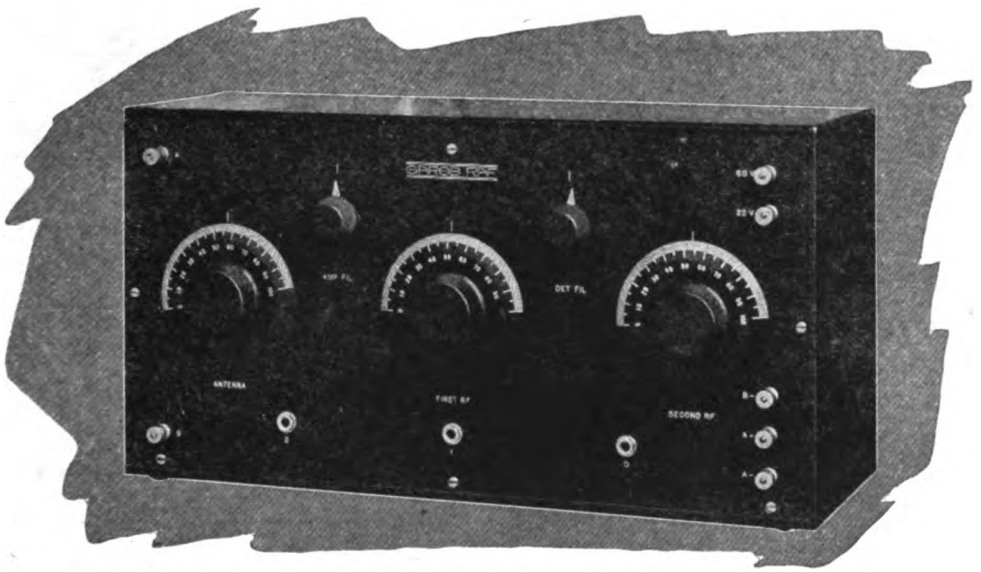

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The better type of receiver WITH THE 5 *improvements*

WHAT is it that elevates the Hazeltine Neutrodyne Receiver above any similar Radio device on the current market? We are answering this question for the benefit of Radio Dealers and Radio Owners who have expressed gratification with the excellent performance of this popular instrument.

The Hazeltine Neutrodyne Circuit is an inherent part of the Garod Broadcast Receiver illustrated above.

And the five outstanding features of this receiver are:

1—utter simplicity in tuning
2—freedom from all objectionable squeals
3—clarity and full-bodiedness of tone
4—selectivity and
5—long-distance reception

Before we placed this instrument on the market we made certain that it was the nearest to absolute perfection obtainable. The Garod Hazeltine Neutrodyne Receiver was developed by Professor Hazeltine of Stevens Institute, and Garod Engineers. The finest material and workmanship, coupled with rigid, painstaking inspection makes the Garod Broadcast Receiver, in its handsome mahogany cabinet, the supreme receiver of the times.

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$135
DELIVERED AT NEWARK, N. J.

The ★ HAZELTINE *"NEUTRODYNE"* SYSTEM

GAROD CORPORATION
8 WEST PARK STREET
NEWARK, N. J.

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Your Choice!
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Hundreds of reliable hook-ups and circuit diagrams—practical hints and handy knacks—money-saving tips and pointers on how to make and improve your own sets. Take your pick of all this authoritative information on radio!

PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

There are still a few copies left of each of these back issues — with the exception of January and May, 1923. *While they last* you can take your pick of them at only 22 cents each, to cover cost and mailing. Here's your opportunity to complete your files of POPULAR RADIO and to add to your store of information on just the subjects which interest you.

Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

May, 1922

—Harnessing waves to wire.
—How to make and install your own Receiving Set.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How to use your Radio Set in summer.
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.
—How to use your Phonograph as a loud speaker.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—Radio on your pleasure boat.
—How to make a variable condenser.
—The foolish fear of lightning.

September, 1922

—How to build the Armstrong Circuit Receiver.
—How the Vacuum Tube works.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How the crystal detector detects.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—Tricks with high frequency electric current.
—The most popular transmitting aerial.
—Right and wrong ways of adjusting the Regenerative Receiver.
—How to make a novel variocoupler.

December, 1922

—Radio on your motor car.
—How to select the best coil for your set.
—How to make and use a loading coil.
—How the Vacuum Tube detects.
—A Receiving Set that takes notes.
—How to make a series-antenna condenser.

January, 1923

(This issue, in which appeared Mr. Cockaday's full description of his "DX" Regenerative Receiver is completely exhausted. A circuit diagram of this 3-Circuit Tuner is found, however, in the Question and Answer Department of the April issue, 1923.)

February, 1923

—20 tips on tuning.
—The Hoffman measurement charts.
—Shall I use a "hard" or "soft" tube?
—A novel tuner for shutting out interference.
—How the Audio-frequency amplifier works.
—Pointers on aerials.
—How to add an Audio-frequency amplifier.

March, 1923

—Making moving pictures talk.
—A Receiver without batteries.
—What really guides Radio waves.
—How to get the greatest efficiency out of your Radio circuits.
—How to make a one or two-step Audio-frequency Amplifier.
—How to make a Multi-Layer Coil.

April, 1923

—Ether waves and the Einstein Theory.
—How to use Regeneration without Radiation.
—How to make a crystal detector from a spool.
—How the Vacuum Tube detects and rectifies.
—How to make a simple single tube Receiving Set.

May, 1923

(This issue, in which appeared Mr. Cockaday's description of his 4-Circuit Tuner, is completely exhausted. A diagram of the circuit adapted for use with dry-cell tubes is shown, however, on pages 164 and 165 of the August issue, 1923, which can be supplied.)

June, 1923

—How to use your Radio Set on your vacation.
—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.
—How to determine the constants of your antenna.

July, 1923

—How to install your Radio Set on your boat.
—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

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Forget your battery troubles

The complete line of Exide Radio Batteries meets every requirement in radio receiving

YOUR success in radio receiving depends largely on the quality of your batteries. And you are sure of satisfactory battery performance when you use Exides. A specially designed Exide Battery is now available for every type of vacuum-tube.

Whether you want a long-life storage battery for six-volt tubes, an A battery for low-voltage tubes, or a B battery, you can take your choice of Exide Radio Batteries and be sure of getting the *right* batteries for your set.

For low-voltage tubes

Two newcomers in the Exide radio family are two- and four-volt A batteries for tubes consuming .25 amps. at 1.1 to 1.5 volts, and those using .06 amps. at 3.0 to 3.5 volts. These sturdy little batteries were specially designed to meet the requirements of WD-11 and UV-199 vacuum tubes. Weighing less than six pounds each, they are midgets in size, but giants in power.

Exide Radio Batteries give steady, dependable current with only occasional recharging. They make it possible for you to reproduce broadcast selections in clear, bell-like tones.

In service over a generation

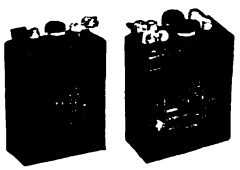
For more than a generation the Exide Storage Battery has helped to turn the wheels of industry. Long before radio broadcasting achieved its present popularity, the Exide proved its worth in commercial and marine wireless. It is used today in a majority of all government and commercial wireless stations. When the American public found in radio a new form of entertainment, the Exide became by reason of superiority the leading radio battery.

You can get Exide Batteries from a nearby radio dealer or Exide Service Station.

Ask the dealer for booklets describing in detail the complete line of Exide Radio Batteries, or write direct to us.

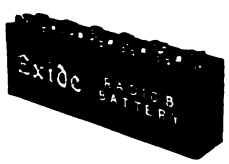
For six-volt tubes

Like all Exide Storage Batteries, the Exide A Battery for six-volt tubes is dependable and long-lasting. It is made in four sizes, of 25, 50, 100, and 150 ampere hour capacities.



Two- and four-volt A Batteries

The new Exide A Batteries consist of one and two cells, respectively, with rated capacities of 12 and 24 ampere hours. The two-volt A Battery will heat the filament for 96 hours; the four-volt A Battery for 200 hours.



Exide B Batteries

give noiseless, full-powered service over a long period of discharge. Designed throughout to prevent electrical leakage. Capacity, 3 ampere hours.

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RADIO BATTERIES

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Service Stations Everywhere **Branches in Seventeen Cities**

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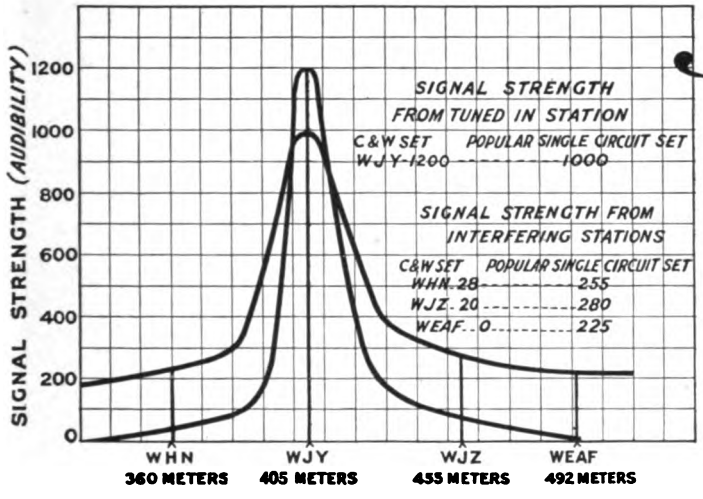
Here is *Proof*



# of Cutting and Washington Superiority

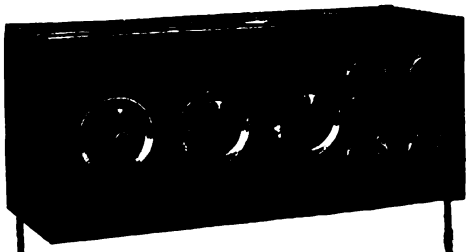
Tested with other broadcast receivers—on the same antennae—listening to the same stations—the *audibility meter proves* that Cutting and Washington Sets give:

Greater Volume from the Station You Want to Hear.
Less Interference from all Other Stations.

Before you buy, *insist* on a demonstration of a Cutting and Washington Receiver (Armstrong patent). Ask your dealer or write direct for complete information.

Dealers: ***The set you can prove to be best is the easiest to sell. Write us.***

Cutting and Washington Radio Corp.
Operating Station WLAG—"Call of the North"
Minneapolis **Minnesota**



How Test is Made

In the graph above a C&W Receiver and a popular single circuit set, using the same antennae, are tuned at New York to station WJY, 405 meters, 25 miles from New York City.

The micro-ammeter shows a signal strength of 1200 for C&W or 200 points greater than the other receiver.

Interference from other stations shown is 25, 20 and 0 for C & W — so low it is almost inaudible. Interference from other stations measures 255, 280, 225 for the other receiver—a serious annoyance.

This result is typical of C&W comparative tests.

Cutting and Washington

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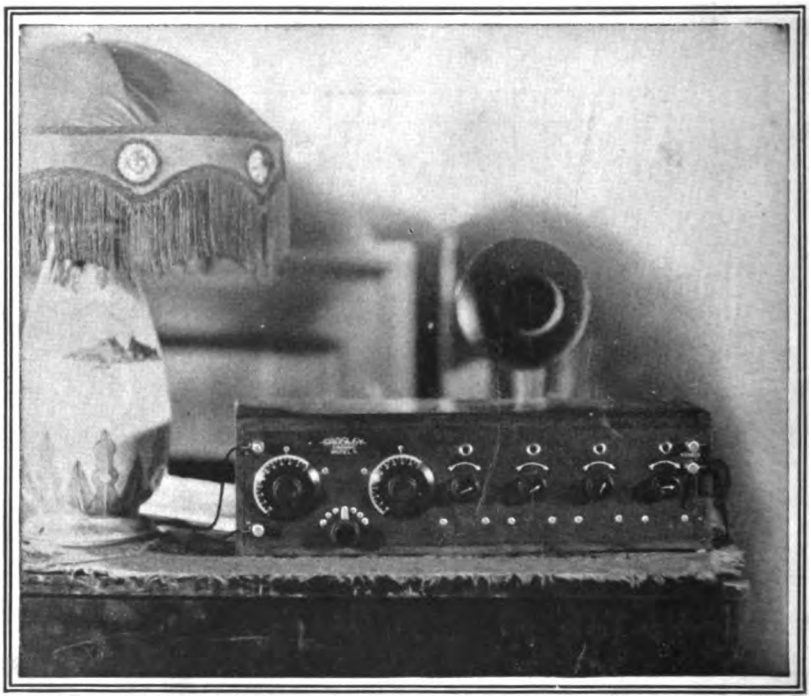

PERFECT PERFORMANCE

Crosley Model X Gives Better Radio Reception

THE popularity of Crosley Model X is becoming more manifest each day.

This four tube set—still priced at $55—maintains its marvelous record of bringing in distant stations.

A man writing from Chatham, Va., says, "First let me state I own a Crosley Model X and you couldn't buy it for the United States mint. I have picked up over 130 stations in the U. S. and have listened to Havana, Canada, North Dakota, San Francisco, all Texas and ships at sea. Keep up the good work!"

You can depend upon an instrument bearing the name

CROSLEY

This name has been accepted as a guarantee of the highest quality at the lowest cost.

All Crosley sets are equipped with the Crosley multistat, the universal filament control rheostat for all make of tubes.

Wave length range 200 to 600 meters.

Other Crosley parts include: Variable Condensers, Knobs and Dials, V-T Sockets, Variometers, Vario Couplers, Rheostats and the well-known Crosley Radio Frequency Amplifying Tuner.

A Crosley Instrument performs everything claimed for it—and more besides.

For Sale by Best Dealers Everywhere. Write for Free Catalog.

We announce a new model—to be known as Model X-J. This has all the features of Model X and in addition—new molded sockets, new rheostats, new condensers with molded plates and jack for head phones. Price $65.

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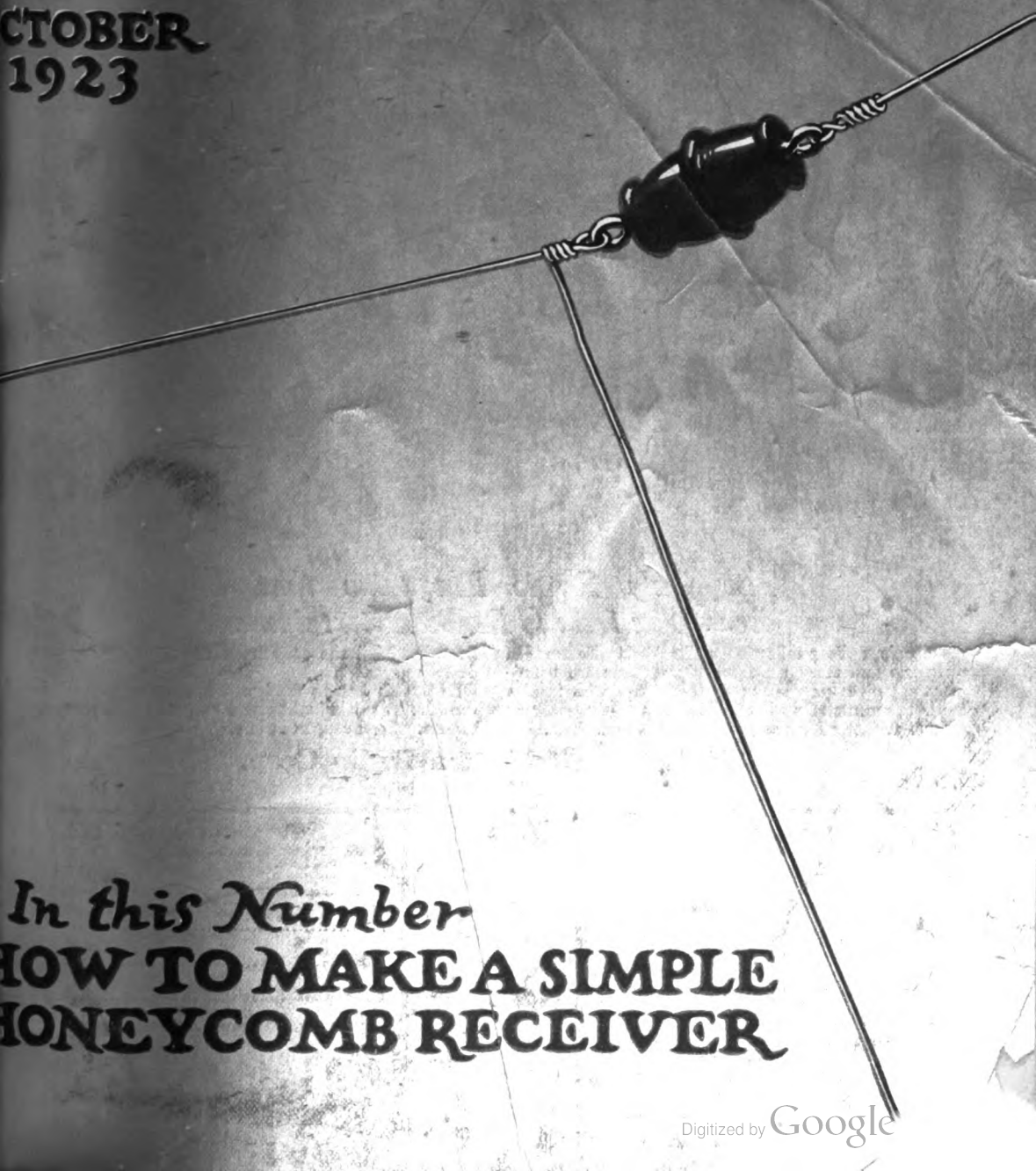
Popular Radio

Edited by KENDALL BANNING

20¢

CTOBER
1923



In this Number

HOW TO MAKE A SIMPLE
HONEYCOMB RECEIVER

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Are You Receiving this FREE Monthly Magazine?

What's in the Air
What's in the Air
A Magazine that Describes and Pictures What Radio Brings to the Home.
"What's in the Air" For You
YOU don't have to know anything about radio to be interested in "What's in the Air."
The publishers believe that there are thousands of people who would own a selective radio receiving set if they realized that radio reception was no longer an experiment; if they knew that no technical knowledge was necessary to enjoy the entertainment and obtain the up-to-the-minute information that the nation's best broadcasting stations have to offer.
Therefore, this little magazine is edited for those who do not own a radio receiving set, or those who have perhaps been made to feel, through owning an inadequate instrument, that radio has not been perfected for popular enjoyment.
This little magazine will come to you each month, if you desire it.
No programs will be published; but what you may expect to enjoy from radio will be described and pictured, as well as many interesting facts about literature, music, science, history, and public men and events that can be found nowhere else in one magazine.
"What's in the Air" costs you nothing. The publishers only request that you read the magazine and show it to your family and friends.
The editors have attempted, in this first issue, to touch lightly upon many of the subjects that will be given life and color in future pages.
From time to time the big features of the best broadcasting stations will be noted in advance so that, if you are a radio set owner, you can "tune-in" and select from what's in the air.
To this end, the largest stations have promised their co-operation.
"WHAT'S IN THE AIR" is published monthly by the Cutting & Washington Radio Corporation, operators of Station WLAG, Minneapolis, and is sent you through the courtesy of the merchant in your community whose name appears on the cover of the magazine.
Editorial Staff:
George B. Dunscomb, Editor
Charles B. Cory, Managing Editor
215 N. Michigan Ave., Chicago
Consulting Editors:
Dr. Fulton Cutting
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The only radio publication of its kind! Features in pictures and story what the big stations are broadcasting; gives personality to the artists who furnish entertainment; tells what radio means to the millions; treats scientific facts so you can understand them. It's FREE. Mail the coupon at the right, giving your dealer's name.

DEALERS: Let us send you a copy of "What's in the Air?" explaining how you can mail it to your customers. Send coupon at left.

Cutting & Washington Radio Corp.

Minneapolis **Minnesota**

Dealer's Coupon

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Minneapolis, Minn.
Gentlemen:
Please send FREE Copy of "What's in the Air?" and explain how I can mail it to my customers, with my imprint on front cover.

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Name of firm .....

Address.....City.....State.....

Mail Your Coupon

Reader's Coupon

Cutting & Washington Radio Corp.
Minneapolis, Minn.
Gentlemen:
Please send me FREE copy of "What's in the Air?"

Name.....

Address.....City.....State.....

Dealer's name and address.....

.....

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Brandes

NEW PRICES

Superior
$6.00

Navy Type
$8.00

Grandpa joins the fans!

When Grandpa first "listened in" it was through a noisy, uncomfortable headset, and he wouldn't try it again till some one called him old fashioned. Then he heard a concert through a Brandes *Matched Tone* Radio Headset. Now his dinner grows cold when there is something good coming over!

He says the Brandes makes all the difference. It fits so comfortably and he gets real music or a clear message every time.

Grandpa may not appreciate what *Matched Tone* means, but he likes the result.

Made in Canada and England by
Canadian Brandes Limited Toronto and London
C. BRANDES, Inc. 237 Lafayette Street, New York City

Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(*Cover design by Frank B. Masters*)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

For advertising rates address E. R. CROWE & Co.
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Yang Chu.

The New GREBE Broadcast Receiver
delights both ear and eye—
Doctor Mu.

REGENERATION and Tuned Radio Frequency Amplification find their first successful combination in this Receiver. The 20-foot silk-covered wire, readily concealed behind the picture moulding, is the only antenna required.

The attractively finished walnut cabinet has compartments for all necessary batteries.

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Western Branch, 451 East 3rd St., Los Angeles, Cal.

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PAGES WITH THE EDITOR

ONE of the most carefully written, re-written, edited and illustrated of articles that the Editor has ever struggled with will appear in the next number, "How Ether Waves Really Move," written by the scientist who evolved the Gliding Wave theory, Dr. Reginald A. Fessenden himself. The story of how this article was developed may give the reader an intimate glimpse into the editorial sanctum and its method of work.

* * *

FIRST of all, Dr. Free, the Contributing Editor, travelled from New York to Boston, and spent a day with Dr. Fessenden in his study. The notes gathered there were then reduced to typewritten form, to serve as the framework for the article.

* * *

AFTER this outline had been studied by Dr. Fessenden and the numerous references and other data had been supplied, the Editor sent his private secretary, Miss Weintz, from New York to Boston to transcribe the article direct from Dr. Fessenden's dictation.

* * *

THE next step was to re-check the data —a task that occupied a good part of Dr. Free's time for several days—and re-submit the completed article to the author for his final revision and O.K.

* * *

AND after all that a photographer was sent to Dr. Fessenden's study to make exclusive pictures for use as illustrations, and Dr. Fessenden's private files were ransacked for photographs of scientific and historical value that could not be had anywhere else in the world—pictures that will be published for the first time in POPULAR RADIO for November.

* * *

IT may be interesting to observe, in this connection, that the four foremost authorities on the Heaviside Layer theory (the four "Biggest Guns," as one scientist calls them) may properly be designated as Dr. Fessenden, Dr. Elihu Thomson, Sir Oliver Lodge and Major-General George O. Squier. And all of them have written articles on the subject for POPULAR RADIO.

* * *

IMPRESSIVE evidence of the eminently practical service that POPULAR RADIO is rendering to the amateur and to the novice by stimulating his experimental work is offered by one of the largest and best radio stores in New York, which recently bought several hundred copies of the magazine for distribution among its customers.

* * *

WHAT more convincing proof can be offered of the value of POPULAR RADIO to the radio industry? Yet the unique feature of this value lies in the fact that POPULAR RADIO serves the industry not by telling the dealer how to sell—but by telling the fan what he really needs and what he ought to get.

ALL of which imposes a trust upon the editors which they are and must be jealous in guarding in the protection of our readers. The technical and semi-technical articles must be sound scientifically, authoritative—and like Caesar's wife, above reproach, free from bias and from commercial influence.

* * *

If you see it in POPULAR RADIO, *it's so!*

* * *

So great and so many have been the demands of our readers upon the Technical Editor that during the past few months his office has been assuming less and less the semblance of an editorial sanctum and more and more that of a reception room of a public service corporation. Radio fans who seek his advice, not satisfied with letters, telegrams and telephone conversations, have been calling upon him personally, in many cases lugging along with them their receiving sets that require expert treatment, and await their turn in the outer office with varying degrees of patience.

* * *

OF course, this personal and expert service is very delightful to the visitors as well as to the Technical Editor; he is an old-time amateur himself and he takes the real amateur's pleasure in helping along a fellow fan. But the time he has devoted to this Good Samaritan business takes his time away from his editorial work on POPULAR RADIO—and our 500,000 readers are the losers!

* * *

IT is obviously unfair to our readers to deprive them of any part of the Technical Editor's services. So a new ruling has had to be put into effect that all questions from our readers, including personal calls, must be referred to the Service Department—and the Technical Editor thus be relieved of a distracting burden and be enabled to devote his attention exclusively to the preparation of material that can be published in POPULAR RADIO *for the benefit of the many.*

* * *

WHAT other solution is possible?

* * *

HAVE you noticed the distinctly international flavor of POPULAR RADIO? The scientific world (which knows no geographical boundaries) is literally being combed for material of value and interest to our readers. General Ferrié and Edouard Belin of France, Sir Joseph J. Thomson, Sir Oliver Lodge and Prof. J. A. Fleming of England, Senator Marconi of Italy, Nikola Tesla of Serbia, Dr. Emil Wiechert of Germany, to say nothing of such Americans as Dr. Irving Langmuir, Dr. Lee De Forest, General Squier, Dr. Elihu Thomson, Dr. Ernest F. Nichols, Prof. J. H. Morecroft, Dr. Reginald A. Fessenden, John Hays Hammond, Jr., John V. L. Hogan, Paul

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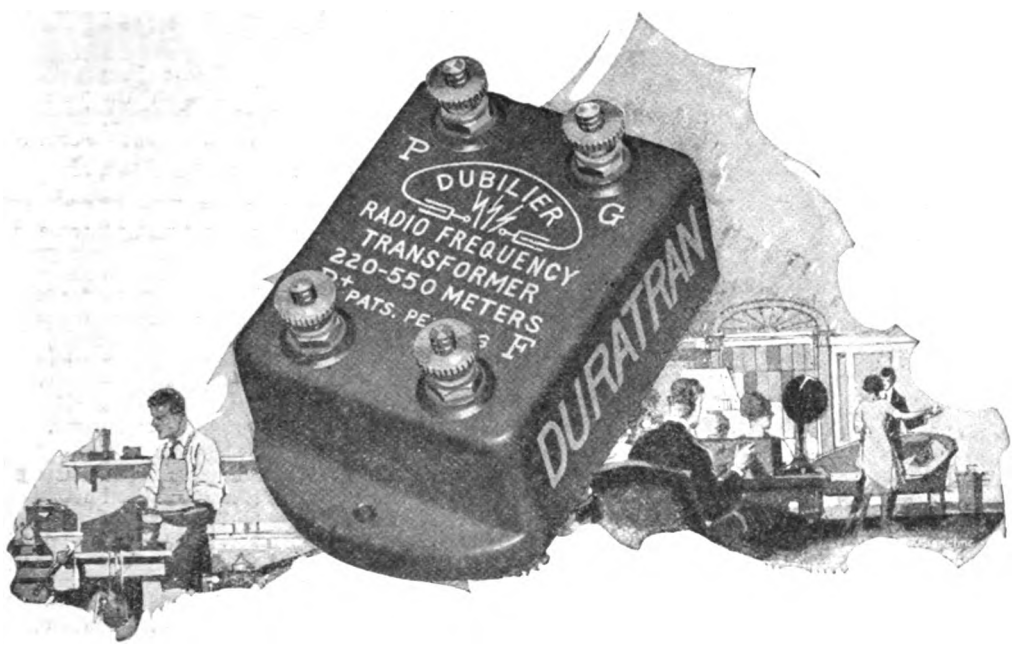

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Amplification on all wavelengths

THE Dubilier Duratran is the supreme radio-frequency transformer. It amplifies powerfully and uniformly *over all the wavelengths* now used by broadcasting stations.

Price $5.00
At all good dealers

DUBILIER CONDENSER AND RADIO CORP.
48-50 West Fourth Street, New York

DUBILIER DEVICES

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PAGES WITH THE EDITOR

(Continued from page 6)

Godley and our own Laurence M. Cockaday (to mention only the first to come to mind) furnish a galaxy of talent that no magazine can excel.

* * *

THE steady and gratifying growth of POPULAR RADIO is bringing with it a correspondingly steady pressure upon the Editor from manufacturers, dealers and inventors of radio apparatus for what is technically known in publishing circles as "write-ups." Apparently every manufacturer of and dealer in radio parts and radio sets wants to see his particular product exploited in our editorial pages. This desire can be easily understood. But in the protection of our readers no article or item or picture has been or will be used in the editorial pages of this magazine except those that (in the belief of the Editor at least) convey information of practical value and interest, that are sound scientifically and that are *entirely free from the taint of commercialism.*

* * *

The editorial pages of POPULAR RADIO *are not for sale!*

* * *

IN the September issue the Editor cited a typical instance in which a prospective advertiser attached an $1,800 contract to a write-up—the contract to be in force only in case the write-up was published. Both the contract and the write-up were sent back by return mail.

* * *

DURING the past month several similar instances have come up. As evidence of the definite and clean-cut attitude of POPULAR RADIO toward all attempts to prostitute its editorial pages with write-ups, reading notices and other forms of press agentry, the Editor is quoting below his response to a well-known advertising agency which submitted, with an advertising contract, pictures and descriptive matter of a patented and manufactured device that is on the market. The letter speaks for itself:

* * *

"I WISH that I could give you some practical evidence not only of the number of similar requests that pile in upon this office, but also some conception of the pressure that is being applied by manufacturers and dealers to force their way into the reading pages of this magazine. In not a single instance, however, has any press agent propaganda of any kind whatever intruded upon our text pages. This ruling is applied to everyone without discrimination and no exception can be made.

* * *

"IT is no small part of my editorial task to explain to manufacturers and dealers—particularly to those who advertise in this magazine—the compelling necessity of establishing such a policy and adhering to it most carefully. Many of these manufacturers and dealers have been accustomed to advertise in the trade papers whose editorial columns are more or less open to the advertisers; indeed, in many cases the publication of write-ups is entirely dependent upon the amount of advertising that accompanies it.

* * *

"POPULAR RADIO is not a trade paper nor a technical journal; it is a strictly high grade magazine of standing in scientific circles, with large and constantly growing circulation among radio novices, radio amateurs, scientists and laymen who are interested in science. In order to attract and to hold this discriminating circulation it is of paramount importance that our editorial pages will be absolutely devoid even of the *suggestion* of commercialism.

* * *

"No article or item or picture that has ever appeared in POPULAR RADIO has been published directly or indirectly as the result of pressure from our business office.

* * *

"AS a matter of policy, POPULAR RADIO has not published nor will it publish knowingly any picture of a patented and manufactured article that is on the market.

* * *

"IN brief, POPULAR RADIO is edited solely for big circulation and that big circulation cannot be attained except by an editorial content of the highest possible standards that is entirely untainted by commercial considerations.

* * *

"THIS policy has not been adopted haphazardly or as a matter of mere theory; it has been adopted as the result of twenty-five years of practical experience in professional publishing. It is the only policy that can assure a large circulation of the unusual character which this magazine enjoys—a circulation from which the advertisers must ultimately and necessarily profit."

* * *

With the next number—November—POPULAR RADIO will be enlarged by about 60 pages, and the price will advance from 20 cents a copy to 25 cents a copy. The November number will be on the newsstands October 15th. Ask your newsdealer to reserve a copy for you. *Do it today!*

* * *

EVERY reader can help the Editor produce the kind of magazine that he likes best by writing in his suggestions. In what specific ways can POPULAR RADIO be improved?

Kendall Banning

Editor, POPULAR RADIO

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Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

A. J. HAYNES

Assoc. Institute of Radio Engineers

Designer of the Haynes Circuit and the Haynes Selector

THE HAYNES CIRCUIT HAS MADE GOOD

Never before has anything met with such instant fame and enthusiastic endorsement everywhere as the Haynes Circuit. Mr. Cockaday's notable description of "How to Build the Haynes DX Receiver" as published in September Popular Radio has solved for once and for all the matter of long distance receiving range for the average man.

1000 MILES for $15.00

LAURENCE M. COCKADAY, R. E., technical editor of Popular Radio, describes the Haynes Circuit as the ideal set for the average man who demands not only the best in local reception but the extreme in long distance range as well.

Its appeal is universal; to the experienced amateur because of its astonishing long range reception and wonderful selectivity; to the radio novice because of its ease in construction and operation. So simple that no one can possibly go wrong.

FREE *For those who were not fortunate enough to see Sept. Popular Radio we have had printed Mr. Cockaday's article just as it appeared in the magazine. Send a 2c. stamp for your copy. You owe it to yourself to read about this wonderful combination of simplicity and efficiency in radio.*

Complete Parts for the Haynes Circuit

Haynes .00023 Condenser	$3.50
Haynes Bank Wound Coupler	4.35
Fada Rheostat	.75
Fada Socket (Panel Mounting)	1.00
Switch Arm	.20
4 Switch Points and 2 Stops	.06
10 Binding Posts	.50
2 3-inch Dials	.90
1 Dubilier Grid Condenser .00025 mfds. (with leak mounting)	.45
1 Grid Leak 1 meg	.35
Bus Bar, Solder, Copper Lugs and all miscellaneous material	.55
7x15 Grade A Hard Rubber Panel	1.50
Panel Drilled for Mounting all the above instruments (extra)	1.50

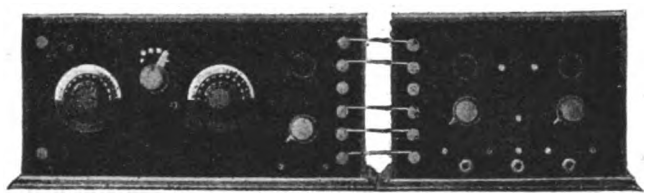
Complete Parts for Haynes Two-Stage Amplifier

2 Haynes-Griffin A. F. Amp. Transformers at $3.85	$7.70
2 Fada Rheostats at 75c	1.50
2 Fada Sockets at $1.00	2.00
2 Double Circuit Tel. Jacks at 50c	1.00
1 Single Circuit Tel. Jack	.40
6 Binding Posts	.30
Bus Bar, Solder, Spaghetti and all miscellaneous material	.35
1 7x10 Grade A Hard Rubber Panel	1.00
Panel Drilled for mounting all above instruments (extra)	1.00
7x24 Panel for assembling circuit and amplifier in one cabinet, already drilled	4.00

Complete price data on accessories such as tubes, phones, batteries, cabinets, sent upon request

The Haynes Two-Stage Amplifier

The remarkable results achieved by users of the Haynes Circuit have created a widespread demand for an amplifier permitting the use of a loud speaker. Mr. Cockaday describes this month the amplifier developed by Mr. Haynes for this purpose. Exact parts specified by the designer and the author are listed herewith.



How Haynes Circuit Looks When Joined With Amplifier

HAYNES-GRIFFIN RADIO SERVICE, Inc. 41 W. 43rd St. New York City

New York's Largest Radio Store

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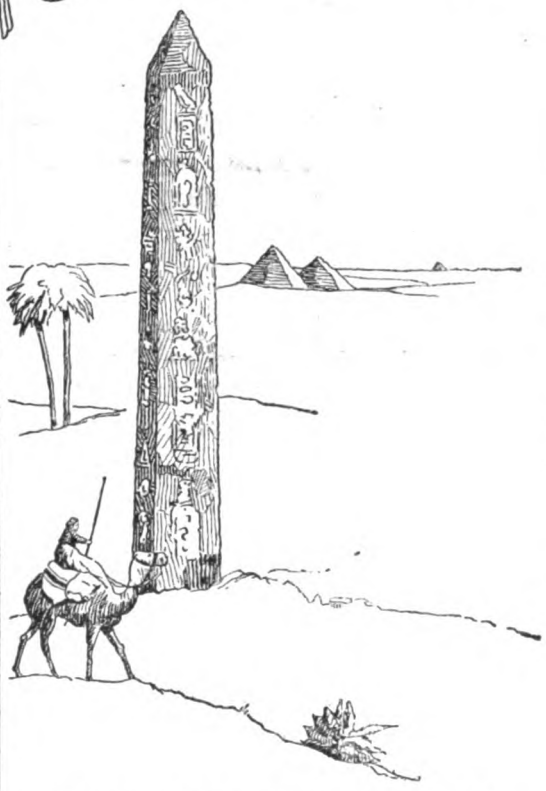
The Masterbuilders of History



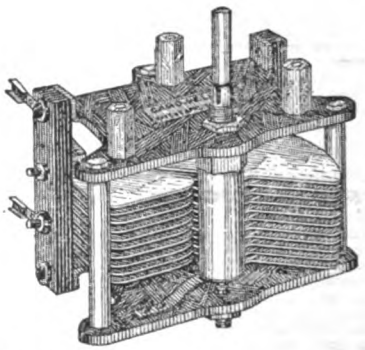
IN EGYPT

great obelisks stand as monuments of achievement to the masterbuilders of the ancient world. Symbolizing accuracy, durability and beauty each obelisk stands firmly on its foundation despite the passage of centuries.

Wars have surged within their shadows. Dynasties have come and gone. New peoples, new races, new civilizations have flourished and fallen, yet the obelisks of Egypt remain as marvels of engineering skill and artistic achievement.

The same ideals of efficiency, ruggedness and craftsmanship are expressed in the Cardwell rotor-grounded condenser. Their correctness is acknowledged by many authorities of engineering distinction:

DOW COCKADAY REINARTZ
WARNER LYNCH HAMMOND



Using Cardwell rotor-grounded condensers will often add a thousand miles to your receiving range. They have such infinitesimal losses at the highest radio frequencies that no one has been able to determine their effective resistance. It is doubtful if engineers can design condensers of greater efficiency. Interference and "body capacity" are unknown with Cardwells.

A Post Card Brings You an Education on Condensers

Ask for Booklet D

ALLEN D. CARDWELL
MANUFACTURING CORPORATION
BROOKLYN, N.Y.

PRICES VARY FROM THREE TO THREE HUNDRED DOLLARS.

SOLD ONLY THROUGH RESPONSIBLE DEALERS.

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"I believe that radio will prove to be our single best medium for pursuing criminals in many kinds of difficult cases, and that it will rank among the best of crime preventives."

—WILLIAM J. BURNS

Chief, Bureau of Investigation, Department of Justice

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Keystone View Co.

The Radio Genius of France

General Gustave Ferrié—the author of the article that begins on the opposite page—is the active head of all the radio activities of the French Government, including the broadcasting station in the Eiffel Tower. And as a scientist he ranks among the foremost in the world.

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Popular Radio

VOLUME IV OCTOBER, 1923 NUMBER 4

HOW RADIO IS BEING USED FOR

Checking Scientific Measurements

When General Ferrié, Inspector-General of Military Communications of the French army, was recently awarded *in absentia* the Franklin Medal of the Franklin Institute of Philadelphia, in recognition of his achievements in the field of radio, he prepared a significant statement that was read on that occasion by Major-General George O. Squier, U. S. A. His observations are incorporated in the following article, which has been prepared especially for POPULAR RADIO.

By GENERAL GUSTAVE FERRIÉ

RADIO telegraphy is taking a more and more important place, not only among the various methods of transmission of human thought, but likewise among the processes of research and analysis, for which it can be employed to extend the field of scientific knowledge.

To begin with may be mentioned the considerable services rendered by radio in a great number of questions relating to "time." While moderately precise hourly radio-telegraphic signals are a great aid to navigators in determining their position at a given moment, hourly signals of very great precision, with the aid of astronomic observations, permit this determination with a degree of precision unobtainable by any other process, where the error is of the order of ten meters. It was by this means that the difference in longitude between the observatories of Paris and Washington was determined in 1913. A very great number of analogous determinations have been made in all parts of the world by this method, which has now become classic.

Under the direction of a special committee appointed by the International Unions of Astronomy and Geodesy, an international operation of this kind is in progress. The object is a redetermination, by this method, in co-operation, of the principal geographic points of the world with the greatest degree of precision attainable. One of the projects in view consists in determining, first of all, the position of three equidistant points and situated approximately on the same parallel at some medium latitude, such as San Francisco, Algiers and Shanghai. The sum of the three differences of longitude between these successive pairs of points should be 360 degrees. The departure from this figure will deter-

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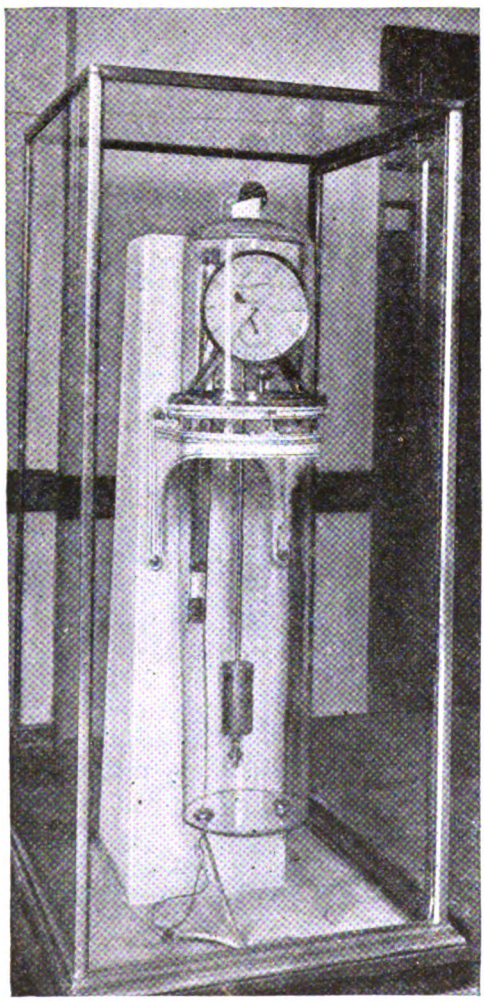
mine the value of the precision actually obtained. Without entering into the details of the project, it is interesting to point out that in the operation new processes and highly perfected apparatus will be employed, as well for the astronomical observations as for the radio-telegraphic operations. A first series of preliminary observations, with the object of checking the methods and calibrating apparatus, is likely to be made at the end of the present year or in 1924.



U. S. Naval Observatory

ONE OF THE GOVERNMENT'S "OFFICIAL CLOCKS"

One of the three special clocks used in controlling the radio time signals sent out by the Arlington station of the United States Government. Each clock is kept in a sealed glass case from which part of the air has been pumped out, and which is kept at a temperature of 84 degrees.

If the precision with which the relative positions determined is only a few meters, as it is hoped, it will be possible, in repeating the operations several years later, to be assured that these relative positions have not changed, taking into account the displacement of the pole. If otherwise, the difference observed would be attributable to a deformation of the earth's crust, and a methodical study of that subject might then be undertaken.

In operations of the kind just outlined it is necessary to know as exactly as possible the velocity of propagation of Hertzian waves on the surface of the earth. Already it has been shown that this velocity differs very little from the velocity of light. New measurements are shortly to be undertaken to increase the precision of this determination. Will it be possible to devise a method by means of Hertzian waves, leading to a repetition of an experiment analogous to that of Michelson? That appears very difficult, but not absolutely impossible. With the Dufour cathodic oscillograph*, it is possible to measure practically, on a photographic plate, intervals of time of the order of the twenty millionth of a second, perhaps even a hundred millionth, counted on the record made by Hertzian waves. It may be possible to devise a method of utilizing this marvelous apparatus for the problem in view.

I may again call attention to the value of Hertzian impulses in investigations on the variation of the intensity of gravity at a given station at different times or at several stations at the same instant. The process is in effect a comparison of the periods of free pendulums at these points; that is to say, a comparison of the number of oscillations of these pendulums during a given time. This comparison is easily effected by

*June issue of POPULAR RADIO.

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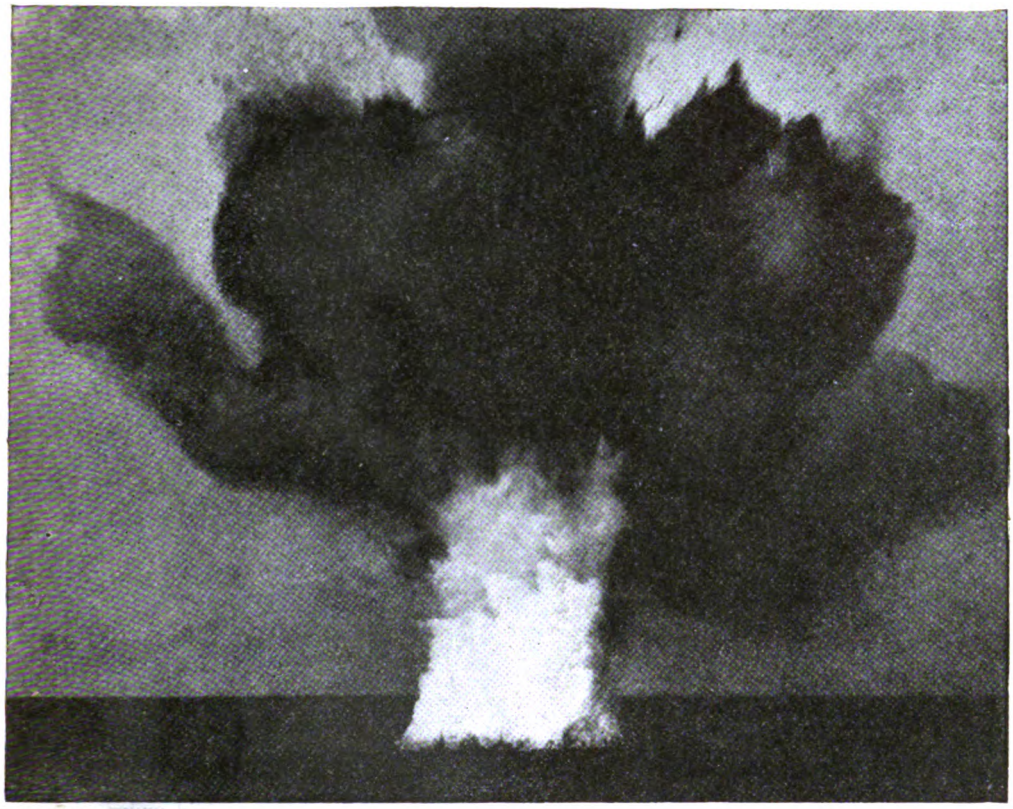

Brown Bros.

HOW RADIO MAY BE USED FOR MEASURING THE VELOCITY OF SOUND UNDER WATER

By causing a great explosion like this under water and measuring the time of arrival of the sound through the water, as compared with the arrival of a simultaneous radio wave at a series of distant stations, it will be possible (General Ferrié says) to determine the velocity of sound in water more exactly than it is now known.

inscribing at each station on the same recorder the oscillations of the pendulum and two Hertzian signals at an interval of several minutes which appear at all the stations.

It has even been possible for Mr. H. Abraham to contrive, by means of three-electrode tubes (audions or triodes) used in radio telegraphy, a kind of clock which is entirely electric and devoid of any mechanical element, capable of producing electric "ticks" of extremely short duration at rigorously equal intervals and adjustable at will. By means of such "ticks" the intervals of time, measured from any origin, registered in the determinations above mentioned, can be subdivided with all necessary precision. Perhaps we may contemplate, in the not too distant future, the employment of these electric clocks in place of the astronomical clocks now used, for these would not be subject, like the latter, to errors and variations due to mechanical causes, seismological, *et cetera*.

Astronomy is even further indebted to the development of Hertzian science. In judiciously combining radio-telegraphic amplifiers with potassium photo-electric cells, it is possible to record luminous signals in the same manner as electric signals. The measurement of the luminosity of stars can then be realized.

For example, by simultaneously re-

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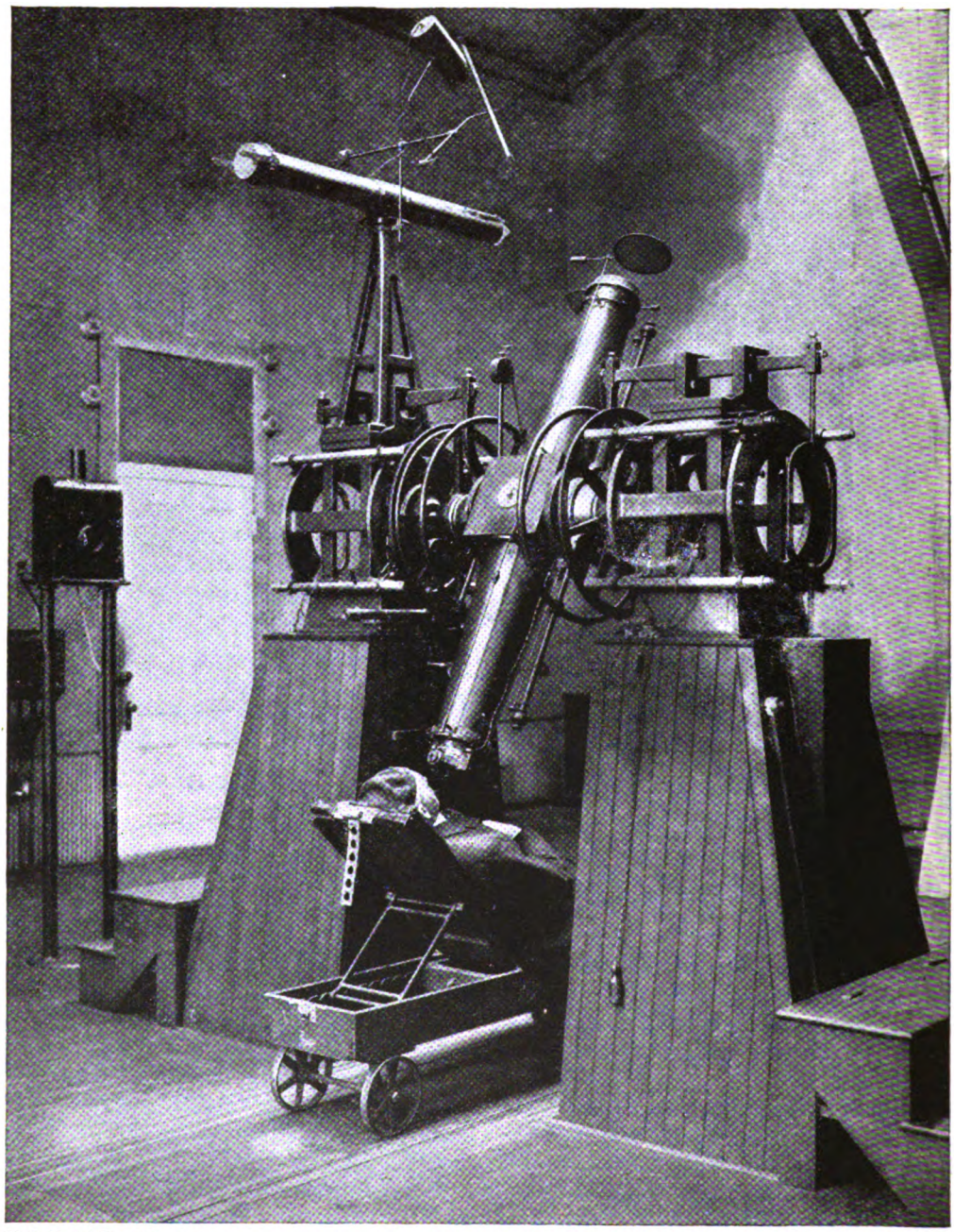

U. S. Naval Observatory

This Telescope Checks Up Uncle Sam's "Standard Time"

The clocks that control the radio time signals and thus set the "right" time for all the United States as well as for thousands of ships at sea are checked each day by observing the exact instant at which each one of a group of selected stars passes the spider-web crosswires inside this telescope. "Standard time" is set, therefore, by the stars by means of light waves coming through the ether, and is distributed over the country by means of other ether waves—the radio waves.

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cording the trajectory of a star in the field of an equatorial telescope and the beats of the astronomical clock, it may perhaps be possible, during the time, to determine precisely the position from the points of the curve which correspond to the passages of the star behind the wires of the reticule. The personal influence of the observer will thus be eliminated and with it a serious source of error. This combination of photo-electric cells and radio-telegraphic apparatus will certainly develop many scientific and practical applications. Will it perhaps lead to a solution of the problem of electrical vision at a distance?

The phenomena of the propagation of waves in air, in water, in the ground, considered either separately or simultaneously with material vibratory movements, have also either made possible or indicated interesting solutions of a variety of problems. In effecting, for example, by means of radio-telegraphic devices, vibratory movements of high frequency, Mr. Langevin has succeeded in producing under water, ultra-audible pencils of rays which could be directed at will and which were reflected from objects in their path. A method of making soundings at sea of very great precision is a notable application of this phenomenon.

It may incidentally be mentioned that it has likewise been possible to measure the velocity of sound in water with great precision, by the following method:

An explosion in the water and a Hertzian signal are simultaneously produced at a given station. At another station, a microphone receives the sound impulse and an antenna the Hertzian signal. Both are recorded on the same chronograph and the difference of time indicated determines the velocity.

Other investigations are in progress for applying the propagation of high-frequency oscillations to the study of the nature and disposition of geological strata. Already interesting results have been obtained.

In a different field, the development of Hertzian technic has considerably improved the precision and increased the variety of methods of electric measurements: Capacitance, inductance, resistance and specific inductive capacity. The measurements of frequency and electromotive force phase, have equally been carried to a degree of precision previously unattainable. With respect to measurements of frequency, it is likewise notable that it will shortly be possible to control the frequency of a transmitter by means of the standard apparatus itself. This prospect will insure the attainment, on questions of frequency employed in practice, of an agreement very difficult to attain with other physical magnitudes.

It has been possible to extend the study of the magnetic properties of iron by making use of currents of very high and adjustable frequency, and by employing the devices of radio-telegraphic technic. The application of waves of very short length may possibly lead to a determination of the periods of vibration of atoms. The application of amplifiers has already made it possible to determine the appreciable time occupied by the molecules of iron in acquiring magnetization. It is also with this apparatus that Mr. Hollweck has rendered audible the emission of alpha particles. Measurements of the terrestrial magnetic field, moreover, can very easily be made by means of a new method evolved by Mr. Perot which again admits the employment of certain apparatus utilized in radio telegraphy.

It would be possible to cite many other researches and scientific work undertaken, in which either radio telegraphy itself or methods and apparatus evolved for it, are utilized. It is, accordingly, obvious that there is a boundless future for the applications of Hertzian waves and that it is to the greatest advantage of all physicists, whatever their specialty, to keep in close touch and cooperate in the development of this branch of science.

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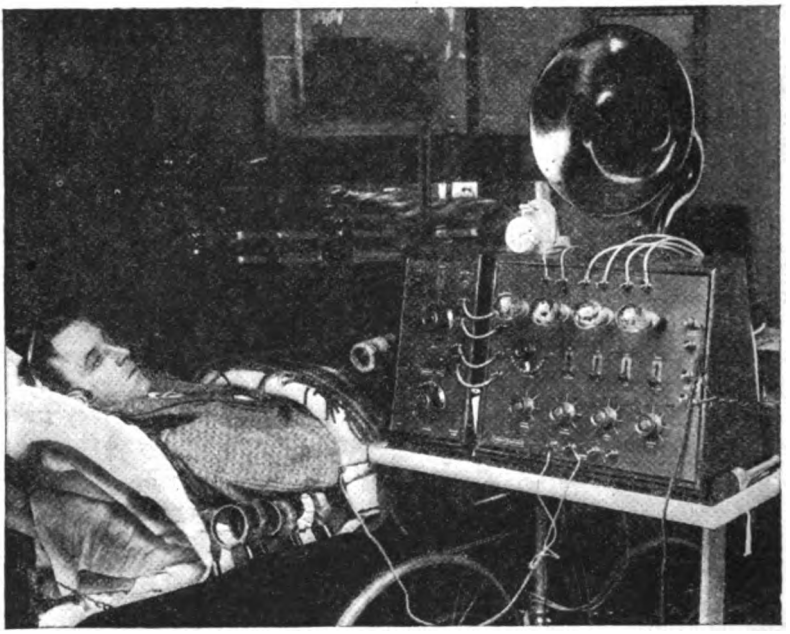

THE NEW INTERNE MAKES A BEDSIDE CALL

This elaborate portable receiver has been installed in one of the London hospitals; it is wheeled to the bedsides of the invalids who call for it.

The Doctor Who Comes Through the Walls

Scientists are learning that broadcast entertainment for invalids has such a distinct therapeutic value that radio receiving apparatus is becoming a part of hospital equipment. Here are some specific cases.

By MRS. CHRISTINE FREDERICK

RADIO is the newest and most welcome sick-room visitor. Its companionship is not limited to a stated period on special days, but it can bring hourly cheer and diversion every day to those whom illness or disability confines to their rooms or to the bare walls of a hospital. Although the radiophone is rapidly revolutionizing such widely separated fields as the detection of crime and the education of the schoolboy, nowhere else has it a greater field of usefulness as a medium of recreation than in that of entertaining vast numbers of invalids.

One of the first institutions to give the benefits of radio inspiration to its patients was the Pittsburgh Tuberculosis Sanitarium. Here both adults and children may enjoy the entertainment and music over the radio—entertainment which keeps them contented and cheerful during the long weeks when these patients must remain isolated from the outside world. Every one of the 112 beds in the hospital can listen in

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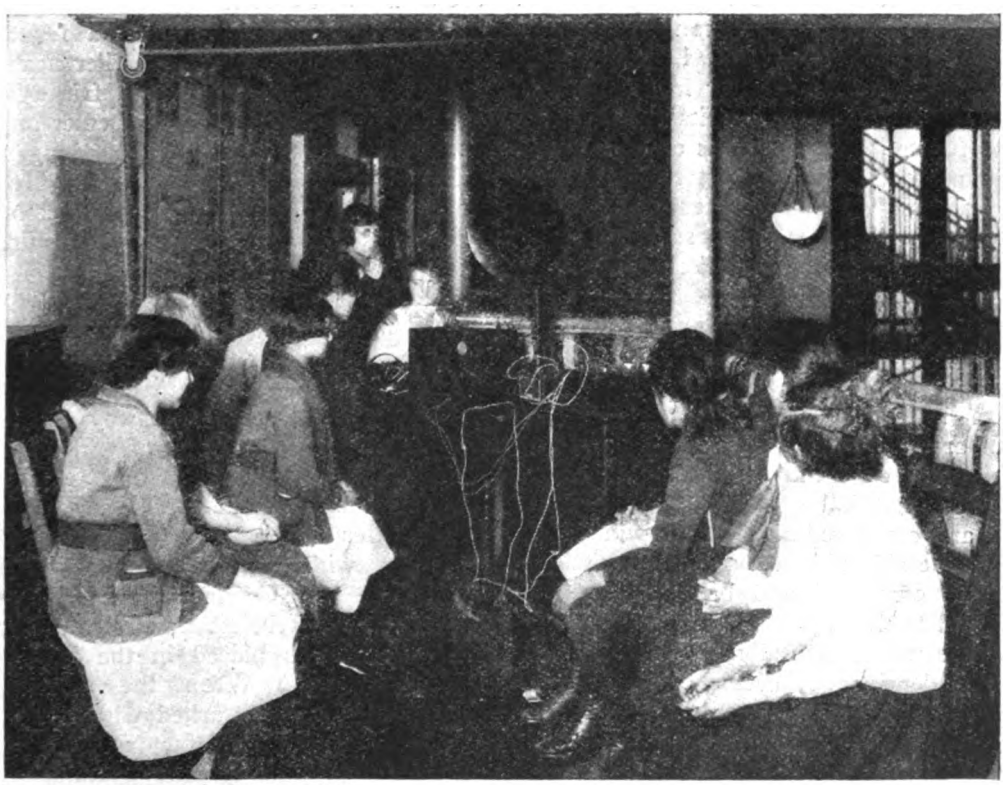
to radio programs. In the adult wards, headphones are used by such of the patients who may care to use them, while the entertainment in the children's wards is received through a loud-speaker. In describing this installation the superintendent reports:

"In some form we have had radio installed for six years, in its present manner for the past three years. We tune in particularly to K D K A our local and nationally known station, although many distant stations are picked up. We have had great success with the plan and would not now be without it."

Other hospitals are meeting with the same success in the use of the radio. One of them is the Bronx Hospital in New York City. It has installed a radiophone on the roof garden where concerts are given to convalescent patients. It also plans to have a receiving set in the wards of those who are bedridden, using headphones so as not to disturb other patients who may not desire to listen in.

Many other institutions are installing some type of radio set to give its patients the advantages of music and cheering entertainment to obviate usual loneliness. The Manhattan Eye, Ear and Throat Hospital, New York City, the Post-Graduate Medical School, and the new Beth Israel on New York's East Side are taking advantage of this distinctly modern sick-room visitor. As L. J. Frank, superintendent of Beth Israel states, "The effect on the patient is bound to be good, and will in my



From a photograph made for POPULAR RADIO

A NEW KIND OF "ETHER" WAVE ENTERS THE LIVES OF THE BLIND

These little patients in the New York Association for the Blind are getting acquainted with a new and far less dreaded type of "operator," who twists the dials of a receiving set instead of plying the instruments of surgery.

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opinion facilitate his recovery. It will be of special value to those patients in separate rooms and also in those cases where the patients are required to remain in the hospital over a lengthy period."

The Broad Street Hospital, located in the financial center of New York City, is planning a new addition in connection with which a complete radio installation is to be made. The director, Dr. A. J. Barker Savage, believes that they are installing radio because "we want to do anything that will add to the patient's happiness, and radio will do it as nothing else can. I am very much in favor of it."

The Fox Hills Hospital (New York), where disabled veterans were sent to convalesce, was one of the first to utilize radio with a Signal Corps set. In other cases local branches of The American Legion raised money for radio equipment in their local hospitals. Still another large hospital with vision to foresee the possibilities of radio to its inmates, is the Worcester State Hospital of Worcester, Mass., of which William A. Bryan is superintendent. In a recent letter he writes: "We wish to place a receiving set in our large chapel which holds six or seven hundred people, so that between dances and while changing reels at picture shows we may have something entertaining other than piano or orchestra. I am also contemplating placing smaller sets in our hospital wards for bed patients. I am convinced that radio will be of considerable aid in making our patients more contented and bring the outside world to them."

We would naturally suppose that persons deprived of eyesight would enjoy more than any other group, music and song from the air. This has been well proved in the case of the New York Association for the Blind, popularly known as "The Light House," in New York City. Early last spring a receiving set was installed; at once these sightless ones began to enjoy the programs. When asked their preference they replied that concerts were the most appreciated of any feature and that the installation was a complete success. It is interesting to note that the letter giving this information to the author of this article was "dictated to and written by one of our blind stenographers." To bring increased joy and amusement into the lives of those so badly handicapped, is one of the most humane uses to which the marvels of radio may be applied.

Probably there is no more restless invalid to be found in the world than a small boy confined to bed and convalescing from scarlet fever or diphtheria. Gee, how a fellow longs to be outdoors! Think what the other boys are doing, and isn't it the hard luck you went and caught this darn old fever! That, surely, is the time "a feller needs a friend!" And just such a friend is being found in radio, who can enter any contagious sick room without any danger, and who will talk to you and sing for you, and tell you whether Princeton and Harvard tied, and everything you're dying to know.

Lucky indeed are patients in the Bergen County Hospital, of Oradell, New Jersey. This is an isolation hospital and the majority of patients confined there are boys and girls. Away over a year ago the boy scouts of Troop 1, under the direction of Patrol Leader K. Wanamaker, made a radio installation in this hospital. It is a standard tube set with loudspeaker, and was erected in the Communicable Disease Building in March, 1922. A little later another set was placed in the Tubercular Pavilion. When the superintendent was recently asked whether the plan had proved satisfactory, he expressed himself as greatly gratified at the results and pleasure given the boys and girls. They have heard broadcasting stations as far distant and separated as Louisville, Kentucky, and Detroit,

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Kadel & Herbert

DR. BROADCAST GIVES HIS PATIENTS THE ABSENT TREATMENT

The use of earphones avoids the danger of disturbing the patients who desire silence in the Beth Israel Hospital in New York, while loudspeakers may be used for the entertainment of an entire ward of convalescents.

Mich., as well as Schenectady and Boston. The children give impressive evidence of their joy in the concerts.

It is easy to understand why radio may play such an important part in the hours of the invalid of the future. Whether confined to one's own room for a slight illness or compelled to endure lingering weeks in a hospital or sanitarium, radio is peculiarly fitted to bring comfort to the invalid. Even a case of slight indisposition causes the

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From a photograph made for POPULAR RADIO

WHERE DISABLED VETERANS LEARN THE RADIO ART

The value of wireless in rehabilitating invalids is not confined to listening in. In the U. S. Veterans' Hospital No. 81 in New York the patients are encouraged actually to build sets in the laboratory—an absorbing and instructive phase of radio work that leads the experimenter into the ranks of the real amateurs.

muscles to relax and make reading in bed a strain to the eyes. Often use of the eyes is forbidden entirely, as in many maternity cases. In countless other instances the patient must lie so flat on the back as to preclude any enjoyment of even a pictorial magazine. After abdominal operations particularly, the body must be kept so still and so much confined to one position as to be almost a torture, while all the time the active mind restlessly seeks something to amuse it and distract it. It is here that the radiophone enters the sick room with its magic charm. The headpieces and earphones may be comfortably adjusted in a lying-down position, or a loudspeaker will enable an entire ward or larger group to listen in collectively.

How the ward of a veterans' hospital (Chelsea Naval Hospital) makes use of radio is picturesquely described by H. C. McNary in the following words; they have the ring of reality:

Several hundred beds are here, all containing hospitalization cases. Some of the invalids are drawing full compensation; some, calling their buddies lucky who have more legs and arms off than they have, are drawing only partial compensation, while others draw nothing and fervently pray that the man from the Veterans' Bureau will succeed in connecting their disability with service—the only way under the law by which they can receive any financial assistance from the government.

Each bed has a phone and a wire runs from each bed to the big receiver that is also placed near a bed. The veteran who operates this lies on his stomach; the nature of his disability prevents him from lying otherwise. But he has cheerfully accepted the inevitable and gets the maximum of enjoyment out of his experiments with the receiver. The only fly in his ointment is that his experiments are

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harshly criticized by several hundred pairs of lungs whenever anything goes wrong.

In one respect at least the disabled veterans are away ahead of other listeners. One of the faults of radio today is that it is too much like arguing with one's wife—all one can do is to listen. But the vets have overcome this by the simple experiment of answering. That these answers have no more effect than can be given them by limitations of puny sound waves has no bearing on the case whatsoever. They answer and their answer certainly adds to the concert.

1st Veteran—"Hey, hurry up will yah, Jimmy. I let me chauffeur take me Rolls Royce out tonight just so's I could listen in."

Jimmy—"All right, I'm gettin' somethin' I tell yah."

Radio—"Brrrr— blink-blank; Station B. V. D. speaking. Prof. Topkicker will give setting up exercises, the first—

1st Vet.—"Wow!"

2nd Vet.—"Raspberry!"

3rd Vet.—"Tell that guy the war's over."

4th Vet.—"Who d'yah think yah talking to?"

Radio—"The first exercise, arm exercise—"

5th Vet.—"What with?"

6th Vet.—"Friends, Romans, countrymen, lend me a pair of arms."

7th Vet.—"Hey, Topkicker, where were you durin' the war?" That's the time I want to take 'em in bed."

8th Vet.—"Hey, Jimmy, shove off. That's too sad."

9th Vet.—"Give us a dancing act."

Radio—"Brrrr, spit, spit—"

10th Vet.—"Who let the cats in?"

11th Vet.—"Is Murphy eatin' soup again?"

Murphy—"Don't talk about me, Clarky, I ain't the guy what said he always eats butter on his demi-tassies."

Radio—"Brrrr! Station S. O. S. broadcasting. Potatoes should be planted six inches below the surface.

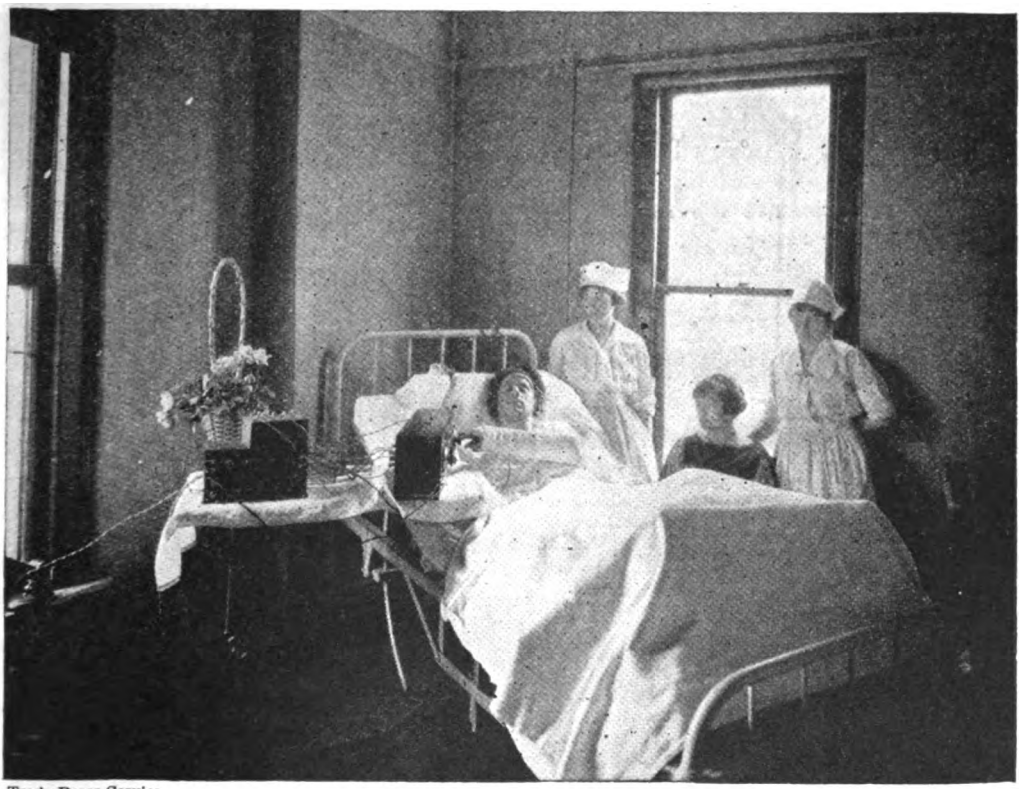
12th Vet.—"For the love of Pete, how did that hayshaker get into this man's army?"

Radio"They should be in rows of four—"

13th Vet.—"With a corporal in each squad."

Radio—"Brrr, crash! Station QMC broadcasting. Bedtime story—"

14th Vet.—"Whadayamean bedtime? We don't go to bed till nine."



Trade Press Service

BEDSIDE VISITORS COME AND GO AT THE TWIST OF A WRIST

To select the callers he wants when he wants them and to dismiss them at will without offense, is one of the inestimable advantages that a receiving set brings to the invalid. This picture shows an installation in a private ward of Mercy Hospital in Canton, Ohio.

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15th Vet.—"Jimmy, yah musta got Philadelphia—lay off that."
Radio—"*Brrr! Brr! Brrr! Brrr!*"
16 Vet.—"Whatya doin' Jimmy, shiverin'?"
17th Vet.—"Hurry up, Jimmy."
Jimmy—"Keep still. I'm tryin' to get Cuba."
18th Vet.—"Well, if somebody don't give me a blanket, I'm gonna get Chile."
Radio—"*Station GHQ broadcasting. Mr. Higgins will speak on clean speech or the curse of profanity. One moment please.* . . . .
(A faint but audible voice is near) "Do I speak into this damn little thing? How the blinkity, blink, blank, blank—"
19th Vet.—"Hot dog!"
20th Vet.—"Take him off, Jimmy, he musta been a second lieuy."
21st Vet.—"Give us some music."
22nd Vet.—"Shove off."
Jimmy—"All right, I'm tuning into COD. Lissun."
23rd Vet.—"Hey, Jimmy, I said *music.*"
Jimmy—"That's grand opera, y' dumb-bell. Ain't you got no education?"
24th Vet.—"Hey, Jimmie, ring off and see if you can find any jazz. We want jazz. Altogether fellows."
All Vets.—"*We want jazz!*"

The popular Sunday services which are features of practically every broadcasting station may truly be classed as those especially appreciated by the shut-in or aged. The weather may be inclement, the distance too far, the conveyance out of order. Yet grandmother may be able to hear her cherished hymns and Sunday sermon! Many a young mother whose small children make it impossible for her to attend Sunday worship, may nevertheless restfully listen in to an uplifting talk and hear an inspiring anthem. Indeed, it is not too much to say that the words of the preacher as heard by radio are more effective than when spoken in the church edifice. There are no new hats to cause our attention to wander, nor no incentive to see what new people are sitting in the Smith's pew. The very fact that the voice comes so directly into the ear, and the attention of the listener is so strained to catch every word, makes the radio message more effective and permanent. Also, the fact that such radio talks are limited to a short fifteen minutes may force the speaker to condense his sermon to better advantage.

If in the year 1950 we could all be looking backward we should probably see that every institution like a hospital or a sanitarium as well as a home was equipped with a radio receiving center. At all events the radiophone will have been proved to be the sick room's most welcome visitor.

International

HIS LOUDSPEAKER DISTURBED THE NEIGHBORING TOWN

When Col. Edward R. Green—known to radio fans everywhere as the owner of Station WMAF in South Dartmouth, Mass.—recently set up a huge amplifier so that his townsmen could all listen in, he received complaints from folks living several miles away!

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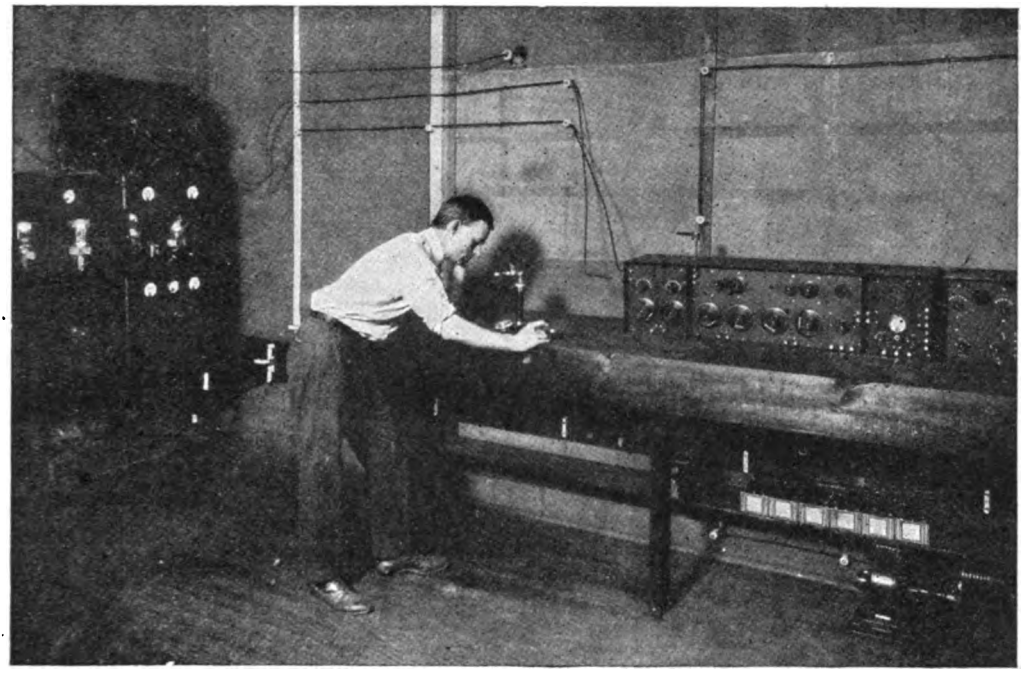

THE COMPLETE SENDING AND RECEIVING APPARATUS

It is necessary merely to "dial" a number—in the same manner as on an automatic telephone—in order to communicate immediately by wired wireless over 50 or 100 miles of 100,000-volt power lines, even to the furthest sub-station on the line.

The Human Voice with a 100,000 Volt Kick

How "wired-wireless" waves are being used commercially in a remarkable manner to establish telephonic communication of a most reliable and important nature over the high tension lines of a great electric light and power company.

By LLOYD JACQUET

WHEN Marconi sent the letter "S" across the Atlantic Ocean in his initial attempt to span the seas by radio some twenty years ago, the telephone, the telegraph and the cables, all wonderful inventions at the time, dropped out of the spotlight to make way for the newcomer in the communication field, the radio telegraph.

The art of radio has since developed rapidly, and today we have achieved the dream of scientists and engineers ever since the invention of radio telegraphy: the transmission of human speech without wires.

We are now again on the threshold of a new era, in which the many merits of radio telephony are combined with the advantages of wire telephony.

It is well known that radio waves

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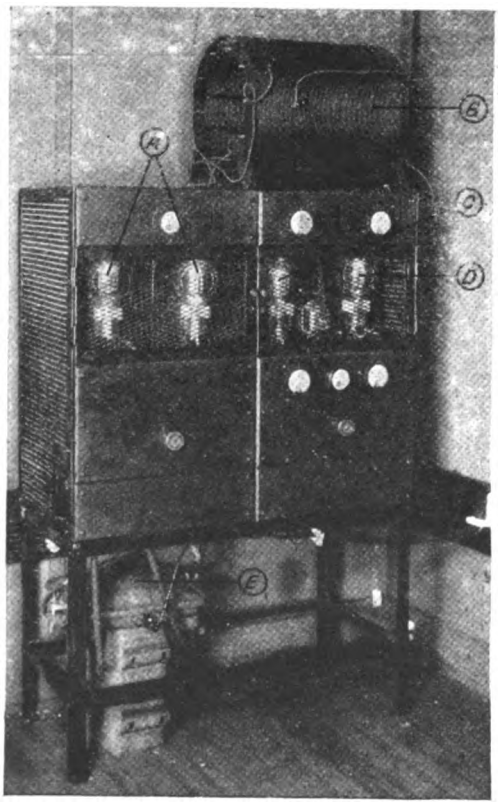
radiate in all directions, in the manner of the concentric water-wave rings which result from the dropping of a stone in a pool of quiet water. This property of radio waves of spreading out in all directions makes broadcasting possible.

Now, radio waves have been caused to follow a conductor—to be guided by a wire—instead of being allowed to travel unrestricted in all directions. To the uninitiated this may appear to be a step backward, but engineers of the Westinghouse Electric & Mfg. Company, who have made an installation of their system on the lines of one of the big western power companies, are convinced that the utility of this system will be as great if not greater than that of its predecessors in the communication field.



THE TRANSMITTER

A, shows the two rectifier bulbs; B, the tuning inductance; C, the modulator tube; D, the oscillator, and E, shows the transformer which furnishes the power to the set.

The name "carrier-current telephony", or wired wireless, has been given to this development of the radio art. It makes use of existing conductors to serve as the medium along which the radio impulses are guided from one point to another. As this system was especially designed for use on power or railway systems, the transmission lines in either case serve as a transmission medium. Sets can thus be placed in generating plants and sub-stations and also on trains, and communication carried on without difficulty.

It is in the electric power services, however, that the Westinghouse system finds its greatest field. The current which we use to light our houses, run motors, and do other work is generated in a power plant. The amount of current needed by a section served by such a generating station varies from hour to hour. For instance, the demand may be greatest during the early part of the evening, or (if in a manufacturing center) during the working day. However, a storm may come up, and many lights are called into service. This imposes upon the generating station a "peak load" as it is called, which must be met.

This proper regulation of the generating plant and sub-stations to take care of the load is in the hands of the "load dispatcher." He is in complete control of the power system and upon his efficient management depends the ability of the system to supply an unusual demand for power.

It is necessary, therefore, that the load dispatcher be in instant touch with all of the sub-stations comprised in his system. A carrier-current system of communication places the load dispatcher in constant touch with any of the operating personnel.

An installation of this type of carrier-telephony system is not any more complicated than that of an ordinary

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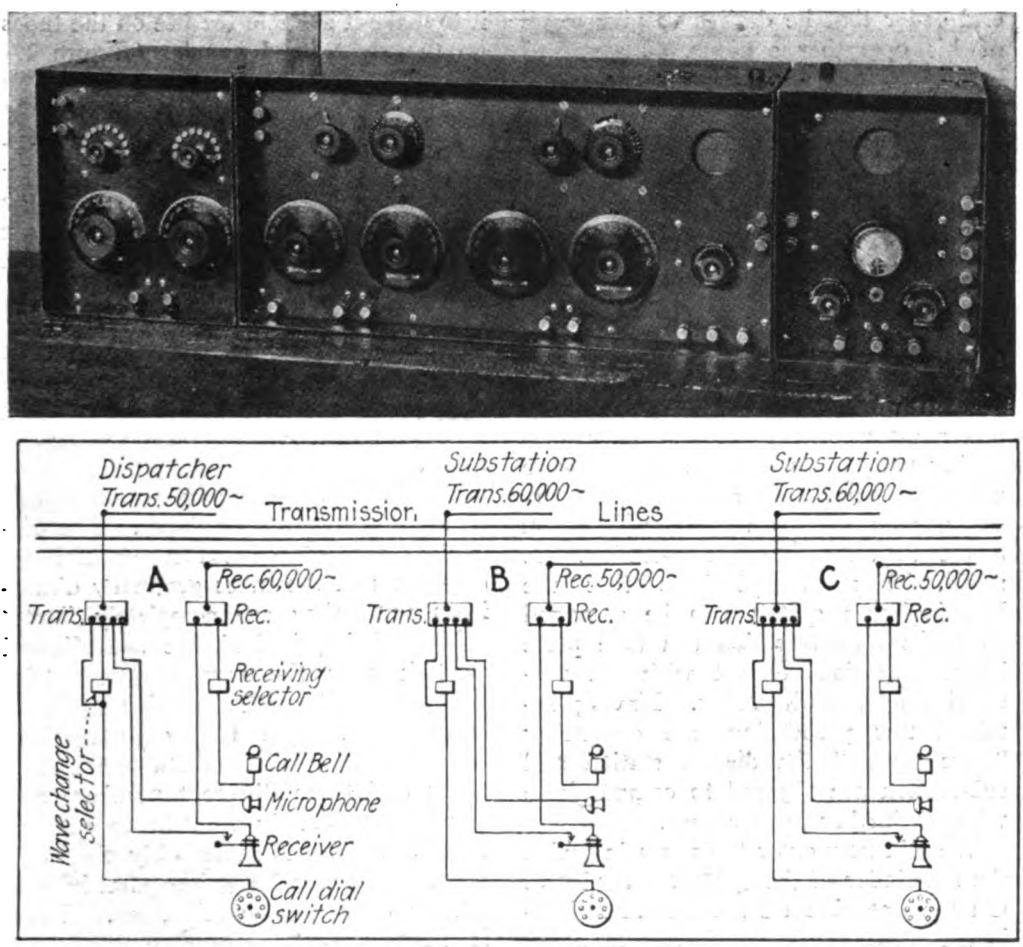

THE RECEIVER AND THE SYSTEM LAYOUT

This picture shows the receiving apparatus, including the tuning units and the amplifiers, which are mounted in strong metal cabinets. Below it is the schematic diagram showing how the receivers and transmitters are connected to separate antennas and tuned to different frequencies—the transmitters to 60,000 cycles and the receivers to 50,000 cycles. The waves pass along the transmission lines to and from the receiving and transmitting antennas.

radio installation, although its simplicity, from an operating standpoint, is much greater.

On entering the office of the load dispatcher or of any other operating personnel on the system, one would scarcely suspect the presence of a carrier-current telephone system. The dispatcher has on his desk an ordinary desk set practically identical with those used for automatic wire telephony. There is a little dial on the base of the instrument which is used for calling the station desired. The only other piece of apparatus in the dispatcher's office is the call bell.

Let us see now what happens when the dispatcher desires a station. He simply removes the receiver from the switch hook, puts his finger in the proper numbers in the dialing mechanism to call the station desired and, in a twinkling, he has the operator at the distant station on the line and is in direct communication with him.

Suppose the dispatcher has a gen-

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eral order that he desires to give to all of his operating stations. Instead of having to call up each one of them separately on his carrier-current telephone, he simply dials a general call and all of the operators respond. He then reads his general order, and they reply in turn acknowledging receipt.

While discussing the operation of the carrier-current system with the dispatcher, doubtless his telephone call bell will ring, as load dispatchers have very little leisure time. In taking up the receiver from the switch hook, his call bell stops ringing and he talks to the calling party. Perhaps he is talking to a distant generating station, 100 miles away, who desires permission to talk direct to an adjacent sub-station. It might be mentioned here that the Westinghouse system can be arranged so that no conversation can take place between stations except with the permission of the dispatcher. Having obtained this permission, the dispatcher hangs up and the distant station and sub-station are allowed to communicate without further interference.

We will now enter the room in which the remainder of the apparatus is placed. On the one side we see a neat switchboard panel upon which are mounted two glass vacuum tubes, very similar to those used in broadcasting stations. Adjacent to this panel is another panel also mounting two similar looking tubes, known as rectifier tubes. (See Figure 1). In another part of the room is the receiving apparatus entirely enclosed in metal boxes and sealed so as to prevent any adjustment except by authorized parties.

The load dispatcher now favors us with a demonstration and through the open door we see him lift the telephone receiver from the switch hook. Immediately a slight hum is heard and all of the tubes glow brightly. We are told that the rectifier tubes take ordinary alternating current such as is used for lighting and power purposes and rectify it to make it suitable for use on the tubes on the right hand panel. (Figure 1.) Of the two tubes to the right, one is known as the oscillating tube and the other as the modulating tube. The oscillator supplies the necessary power for transmittting and the modulator tube modulates or moulds the current into the form of the voice when the dispatcher speaks into the telephone desk set. There are a number of instruments dotted around on the equipment and our attention is directed in particular to one, the needle of which shows severe disturbances whenever one speaks into the telephone. The whole equipment seems to work quietly and performs without fuss or flurry. The dispatcher hangs up his receiver and the brightness of the tubes gradually diminishes until they are completely "out."

Upon being invited, we are allowed to talk over the carrier-current telephone to a distant sub-station some 50 miles away. We follow instructions and lift the receiver from the switch hook, dial three different numbers and almost immediately we talk to the operator. Speech is remarkably clear and one would never know but what he was talking over a wire telephone. There is scarcely any perceptible hum and much less frying noise than over the regular wire telephone lines.

On discussing the carrier-current system with the dispatcher, we are advised of certain almost unbelievable facts. We are told that the current that is used to carry the voice variations over the transmission lines does not flow in one direction continuously, as water flows through a pipe, but that it reverses hundreds of thousands of times in a second. This is an almost unconceivable rate but this kind of current is necessary to obtain clear transmission. This high-frequency current is generated by the oscillating tube of the transmitter, the tube being connected in an Armstrong oscillating circuit familiar to all radio fans, and the oscillating currents are

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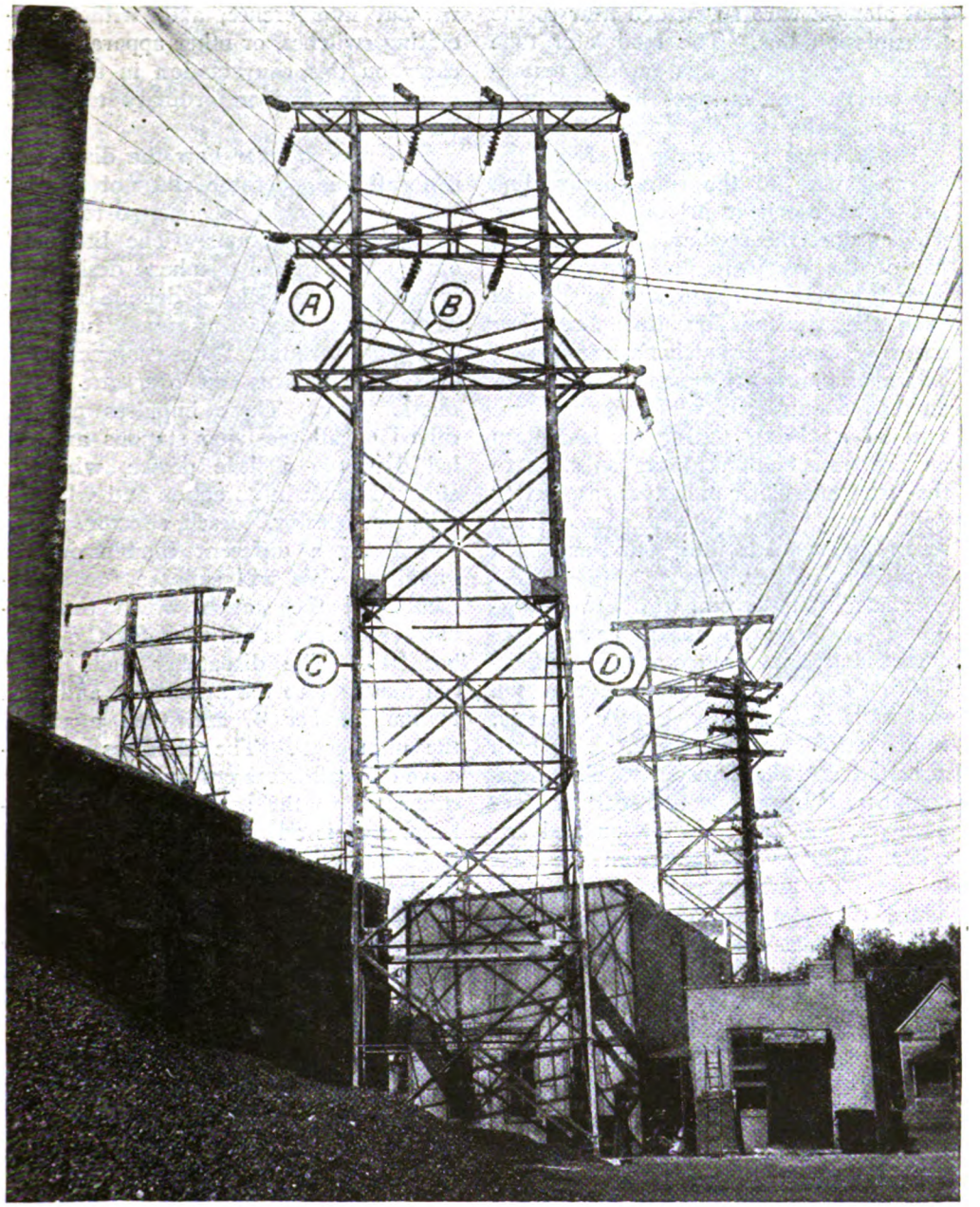

RADIO ANTENNAS INSTALLED ON POWER TRANSMISSION TOWERS

Here are shown how the transmitting antenna A, and its lead-in C, and the receiving antenna B, with its lead-in D, are suspended by insulators from the steel framework of the tower, and directly underneath the power lines. This close proximity of the power lines enables the radio waves to "jump the gap" to and from the power lines without any danger of the high-tension current leaking across in the same manner.

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sent along a wire suspended near to the transmission line. The modulator tube moulds or controls this rapidly reversing current and changes its magnitude as one speaks into the transmitter.

The current is transferred from the elevated wire to the transmission line and flows along it in much the same way as does the regular power current. All of the receivers are likewise connected to elevated antennas suspended near the transmission line and they are tuned to the dispatcher's transmitter. These antennas are simply single conductors about 500 feet long and are coupled by being strung on insulators on the transmission towers as close to the transmission conductors as safety will permit. The current passes from receivers, thence to the ground and back to the transmitter.

It has been the aim of the Westinghouse company to make its carrier-current telephone system at least as flexible as a wire-line telephone and the system is consequently, *duplex;* that is, conversation may be carried on in both directions and simultaneously. This is accomplished by using two carrier frequencies, one for transmission and another, differing enough from the first to cause no interference, for receiving. Thus, two stations talking, A and B, would work as follows: A might transmit on 7,500 meters and receive on 5,000, and B would then transmit on 5,000 meters and receive on 7,500. By the use of these two different frequencies, A and B can both talk and listen without interference, and, without operating switches, or other apparatus, can carry on this conversation in the same manner as over an ordinary telephone line.

You may wonder how the dispatcher can call one operator and not another when he has only one line, so to speak, to all of his stations. The little dial on the base of the telephone desk stand is arranged to make a definite number of contacts, depending upon how far it is pulled around. These contacts send electrical impulses out over the transmission line. These impulses are received by all receiving stations and are led down to a little device, which is almost human in its action and which is called a selector. Each selector is adjusted for a different combination of impulses. We will suppose for a moment that the station which the dispatcher desires is adjusted for the number 949. The dispatcher pulls down the dial first to the number 9, and then to the number 4, and then again to the number 9. The impulses are received by all receivers and all selectors connected to the line, but only the selector that is adjusted to operate at 949 rings its bell. The operating action of the system is akin to the combination of a lock. Only one type of key will open a good lock although many different keys may be inserted into the keyhole. If the operator desires to call some other station, he simply hangs up his receiver for an instant, then removes it and calls the station desired.

How to Build the Super-Heterodyne Receiver

IN *the next number of* POPULAR RADIO—*the first issue of the enlarged magazine—will be published another of the famous "How to Build" series of articles. The Technical Editor, Laurence M. Cockaday, R.E., has been experimenting for months with apparatus which he has built for the express purpose of insuring not only the highest possible efficiency of the set itself, but also the technical accuracy of the article down to the minutest detail. Out October 15th.*

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PRACTICAL HINTS FOR

Coil Calculation

ARTICLE NO. 6

To operate your radio set efficiently, you require a coil of correct design. This series of articles is based upon new and practical laboratory experiments, conducted for the special benefit of amateurs, by—

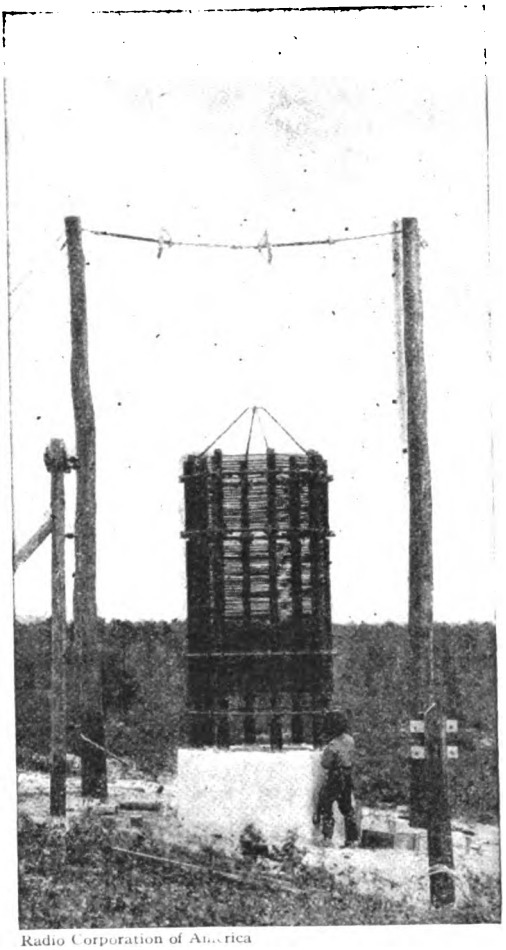
SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

THE first idea of self-induction originated with Faraday, long ago, but he was quite vague about it, and called it "the electrotonic state of a conductor." It puzzled him a good deal, and he treated it almost as if it were some chemical property of the metal, acquired under electrical influence. He named it "electrotonic state" in November, 1831, during his great discoveries in electromagnetic induction generally.

The idea became rather more definite in the hands of Sir William Thomson (Lord Kelvin), who in 1853 gave the mathematical theory of electrical oscillation. He perceived a sort of analogy between Faraday's electrotonic state and electrostatic capacity—only he perceived it was kinetic instead of static—and he therefore called it "the electrodynamic capacity of a discharger." In other words, he found that it was a *constant* belonging to all the wire circuit through which a Leyden jar discharged. Thus in an oscillating circuit there were the two things, both essential to oscillation:

First, the electrostatic capacity of the charged areas:

Second, the electrodynamic capacity of the connecting wire or discharging rod. Resistance came in subordinately, as a damper of oscillation, in a comparatively simple way which he thoroughly understood.



Radio Corporation of America

THE WORLD'S LARGEST OUTDOOR INDUCTANCE

A detail of the enormous multi-tuned antenna of the transatlantic radio station at Rocky Point, Long Island. Compare this giant apparatus to the helix ordinarily used by amateurs, 8 inches in diameter and 12 inches long.

Then, later on, it was realized that just as two wires lying alongside of each other had a mutual coefficient of induction, so that the one induced currents in the other (as discovered by Faraday) —each being susceptible to the rate of variation of the current in the other—so it might be said that every longitudinal part of a single wire reacted on the other parts of the same wire, or, in other words, that the wire was itself

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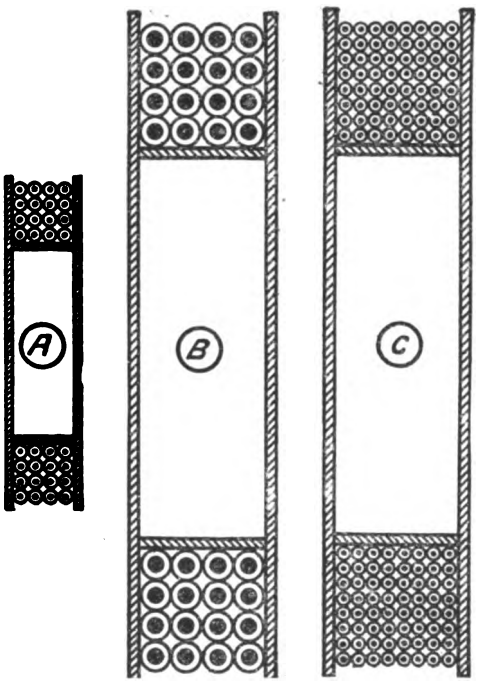
susceptible to the rate of variation of the current in itself. Hence it was possible to speak of not only the mutual induction of two parallel conductors, but of the self-induction of one. And so Maxwell introduced the term "self-induction," and made it quite definite and calculable. Later, Heaviside styled it inductance, to correspond with resistance.

There are two ways of calculating this quantity, now commonly denoted by the letter L. One is to reckon the number of magnetic lines of force which effectively surround a wire carrying a current —the momentum, so to speak, of its magnetic field—and to call that momentum L I, where I is the strength of current. The other is to treat the wire as if stranded, and to reckon the mutual induction of the strands on each other. This can be done by taking it as equal to the mutual induction of two parallel wires at what is called the "geometric mean distance apart": that is to say, at a distance determined by the shape and size of the cross section of the single wire—a distance which can be reckoned as the average distance of the points in such a section from each other. It is all worked out in Maxwell's great treatise, published in 1873; and he gives an expression for this geometric mean distance for different shapes of section. It is important, because it applies, not only to a single wire, but to the cross section of the wound channel in a coil. That cross section may be square, or oblong, or round—as when the coil is shaped like a curtain ring.



It is interesting to note that if we build a coil of certain dimensions A, it will have a certain inductance. If we double all its dimensions, including the diameter of the wire (as in coil B), the inductance will increase very slowly in proportion to the added size. If, however, we keep the wire the same size as in the first coil and at the same time double all the other dimensions of the coil, as in C, we will find that the coil has inductance 32 times greater than coil A.

In practice the section is usually oblong or square. It may be oblong *broadways,* as when one or a few layers are wound cylindrically on a tube; or oblong *depthways,* as when short layers are wound so as to be piled on top of each other, making a sort of disc.

For a coil with one narrow dimension (that is to say, for a winding whose section is a thin oblong, whether the coil is wound horizontally or vertically) the geometric mean distance asunder of its parts is .223, or say a quarter, of its larger sectional breadth.

For a square section, the value is .45 times the length of one of the sides, that is, about half the side of the square.

For a circular section it is .78 or say three quarters of the radius.

For an oblong section in general, the accurate expression is decidedly complicated, involving logarithms and tangents, but it may be taken as approximately a quarter of the width and depth of the section added together; more accurately, $\frac{b+d}{\sqrt{(20)}}$, which is very nearly right. The complete formulas will be found in Maxwell, or quoted in Professor Fleming's comprehensive

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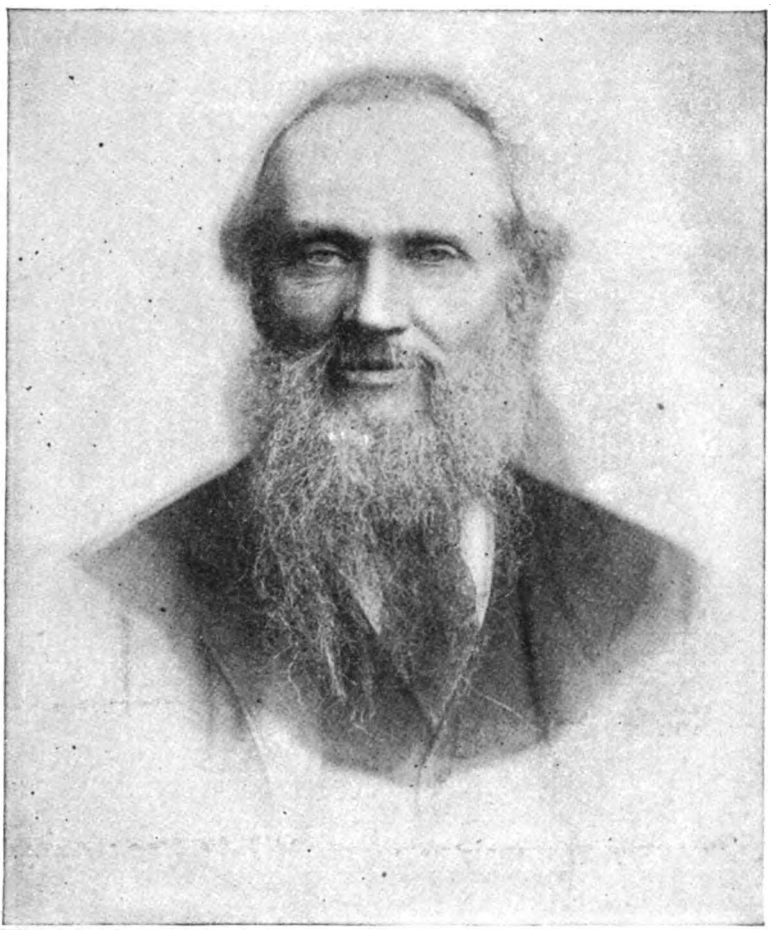

Elliott & Fry, London

THE SCIENTIST WHO EVOLVED THE THEORY OF ELECTRIC OSCILLATION

Sir William Thomson (Lord Kelvin), first perceived that there was both kinetic and static energy in oscillatory electrical discharges. His development of this theory was based upon a thorough understanding of the theory of induction.

treatise and I need not attend further to it now, because I want to concentrate on the most compact section—either a circle or a square. For it is this compactness which gives the maximum self-induction.

That, however, is not all that is necessary to be known, by any means. That only determines the shape of the channel in which the wire is wound. We must know the average size of the channel in relation to the circle of wire so formed, that is to say, we must know the external and internal diameters of the coil in terms of its sectional dimensions. Maxwell calculates that too, though he says it was first worked out by the mighty mathematician Gauss, in 1867; though under what circumstances and for what reason Gauss can have calculated it, I do not know. It will be instructive to some of my readers if I indicate the manner of calculation, though those who like may skip the algebra, which I will defer for the immediate present. Anyhow, the *result* is clear and definite and simple enough. The width and depth of the channel's cross section

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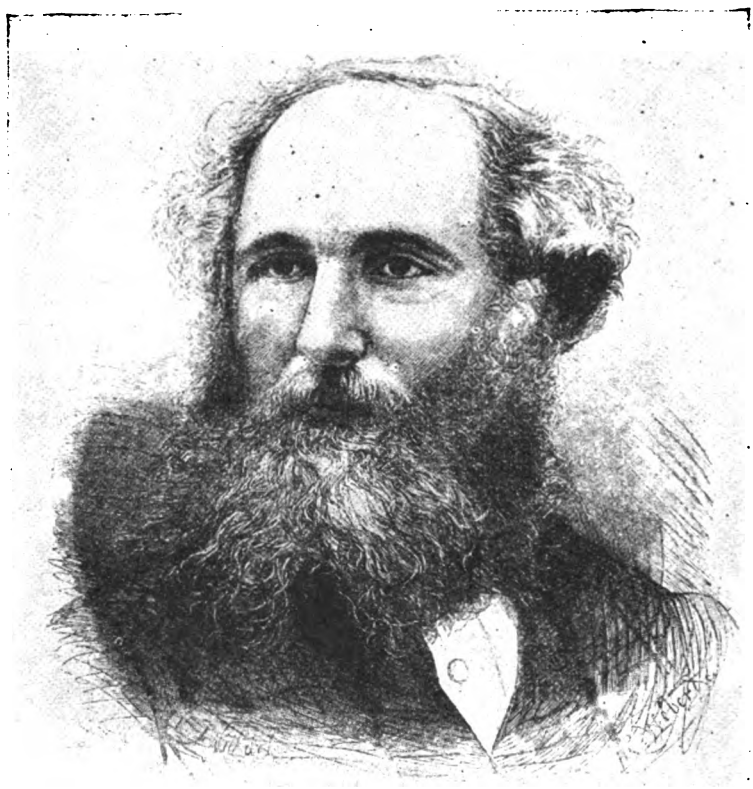

Brown Bros.

HE GAVE THE WORLD THE MATHEMATICAL FORMULAS FOR EXPRESSING INDUCTANCE

"Self-induction" is the term that James Clerk Maxwell gave to the phenomenon that we now call merely induction. He was also the first man to establish the theory of light as an electromagnetic phenomenon.

must be approximately three-fourteenths of the external diameter of the coil, or three eighths of the internal diameter, the external diameter being $\frac{14}{8}$ or $1\frac{3}{4}$ times the internal. That determines completely the shape of the best coil, whatever its size may be. Every coil that we now proceed to speak of is to be of this shape, they will differ only in size, one will be like another magnified. But the wire which is wound on the coils will not be magnified. If it were, the number of turns would remain the same, and the inductance would increase very slowly in proportion to the additional size. It would, in fact, in that case simply increase with the linear dimensions, or, what amounts to the same thing, it would be proportional to the length of wire used.

But if the wire is maintained at a constant thickness, no matter what the size of bobbin on whch it is wound, the inductance increases vastly as the dimensions increase. It increases not only because of the greater length of each turn of wire, but also in proportion to the square of the number of turns. If the linear dimensions are doubled, the number of turns are quadrupled, and therefore the length of wire is quadrupled. The inductance depends on the square of the number of turns, and therefore is quadrupled twice over, making it 16-fold, and the linear dimensions being doubled makes it altogether 32-fold. That is to

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say, increasing the size of the coil, for a given thickness of wire, increases the inductance as the fifth power of the size. In other words, doubling all the linear dimensions multiplies the inductance by 32.

The formula connecting the three things—outside diameter of coil (D), thickness of covered wire (T), and maximum inductance (L_m)—is as follows:

$$\frac{D^5}{T^4} = 66.6L_m$$

Here the D, T, and L must all be expressed in the same units, no matter what those units are; and for convenience L should therefore, in such cases, always be expressed as a length, not in such units as henries or fractions thereof, though these are useful for other purposes.

So also it is best, for radio apparatus, to express capacity as a length, and not in farads or microfarads or micromicrofarads. It is much better to express it in meters, because one usually wants to employ it to calculate the wavelength. The wavelength is 2π times the geometric mean of the inductance-length and the capacity-length, that is, about 6 times the square root of their product. Thus, suppose L is 10 kilometers, and C is 1 meter, the wavelength would be 600 meters. If L is 1 kilometer, and C is 10 meters, the wavelength is the same. If L is 16 millihenries, or 16 X 10^6 centimeters, and C is 100 centimeters, the wavelength will be 240,000 centimeters, or about 2½ kilometers.

By thus working in length units, the calculation is quite simple, and can be done in one's head; and slips of extensive magnitude can be avoided, because there is a common-sense feeling about the size of the quantities dealt with, all the time, which prevents their being accidentally taken hundreds or thousands of times too big or too small, as may easily happen when hastily dealing with meaningless units of quite unsuitable size. To measure things in farads and henries when we want the dimensions of a coil in inches, or a wavelength in meters, is not practically convenient.*

*Sir Oliver Lodge's article in POPULAR RADIO—"A Plea for Easy Specification," September, 1923.

Harris & Ewing

RADIO AS AN EMPLOYMENT MEDIUM

To bring the man without a job to the job that is waiting for him—somewhere—has been one of our important economic problems. The Secretary of Labor, James J. Davis, is using radio for broadcasting practical information concerning just what kind of labor is needed in different localities.

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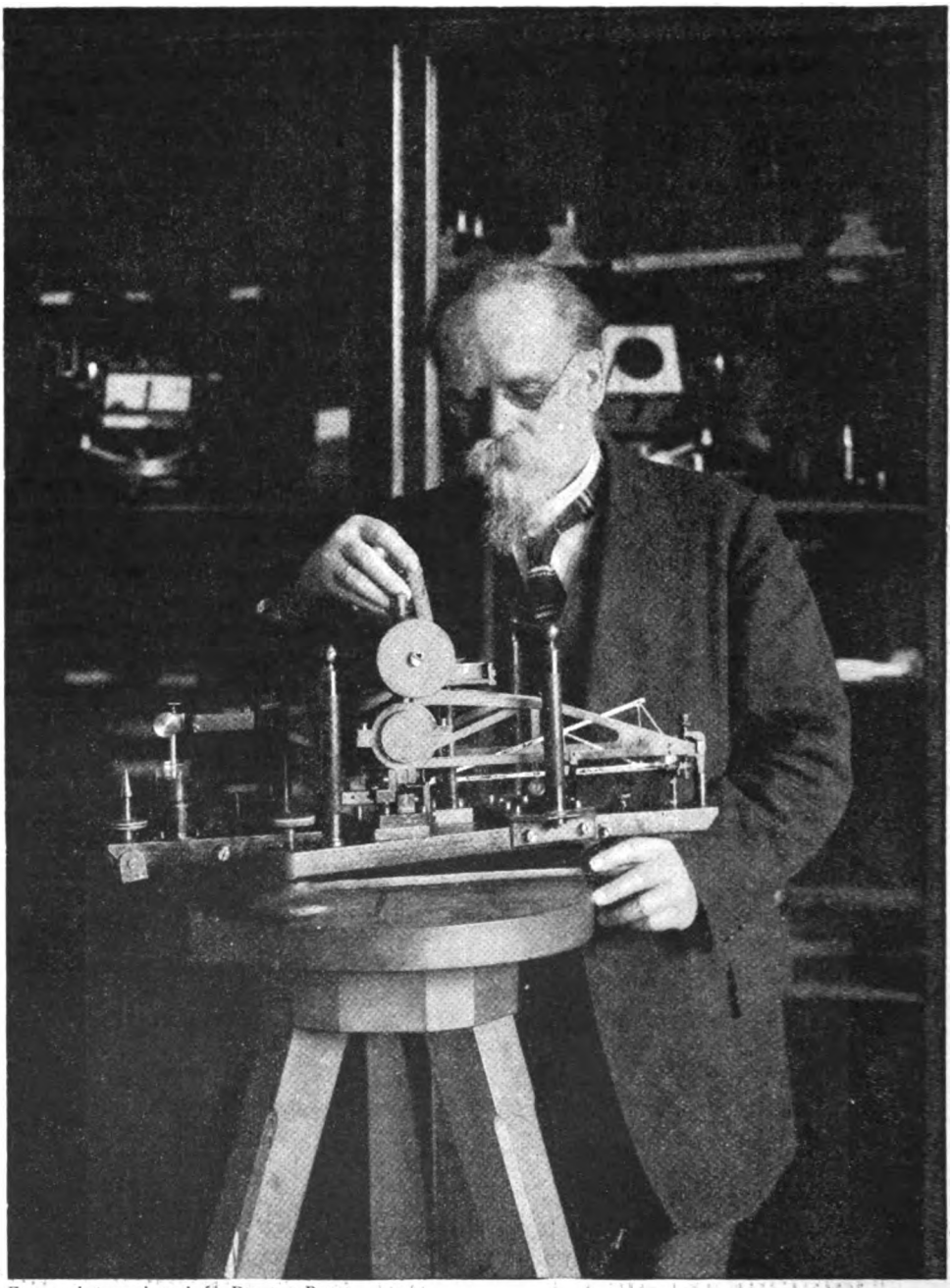

From a photograph made for POPULAR RADIO

"From Ether This Life Comes, and to it This Life Returns"

So states Dr. Emil Wiechert, Professor of Geophysics and head of the Geophysical Institute of the University of Göttingers, Germany. In addition to his work in electrical theory he has made a special study of the mathematical theory of the transmission of earthquake waves inside of the earth. In this picture he is shown adjusting a seismometer that magnifies 100,000 times.

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Are Men Made of Ether?

A remarkable conception of the basic unity of life, matter and electromagnetic waves, as developed from the ether hypothesis by—

EMIL WIECHERT, Ph.D.

WE see in the world an abundance of apparently autonomous bodies. Physics, however, teaches that this autonomy is an illusion, that it is a misconception that is brought about by the imperfections of our senses. As a matter of fact, everything in the world is interrelated. It is remarkable, and may well incline us to humility, to realize that our human senses show us absolutely nothing of the connecting forces—of the force of gravity, of the electrical and magnetic forces, and of the forces which bring about the agglomeration of the atoms into solid bodies.

Physics first had to seek out these forces, but even then it succeeded only in making us acquainted with a few superficial aspects of the processes that are involved. The most important conception which resulted was that there is everywhere present, eluding perception by our senses, a basic substance that is known in Germany as *Weltuntergrund*, or in the parlance of physics, the ether, which secures the connections between molecularly-material bodies.

Strangely enough, it was Einstein's theory of relativity, seeking to deprive the cosmic basis or *Weltuntergrund* of its corporeity, that led to the conclusion that the apparently tremendous effect of the force of gravity which shackles the planets to the sun and ourselves to the earth is engendered by even extremely small differences in the condition of the basic substance, ether.

To understand this, let it be noted that the velocity of light is a measure of this condition. Gravitation on the earth results because here the velocity of light increases from 1 to 2×10^{-16} of its amount with one meter of elevation. On the other hand, molecular matter exerts but an extremely trivial influence upon the condition of the basic structure, ether; even the great mass-aggregation of the sun is unable to alter the velocity of light at its surface more than a 1/500,000th part from the velocity obtaining at great distances.

Thus the ether appears to have predominance over molecular matter.

This impression, much as it does contradict naïve observation, becomes stronger as the physical details are more fully considered. One is accustomed to regard inertia and opacity as those attributes which really give matter its corporeity. But electro-dynamics instructs us to look for the cause of inertia in the basic substance ether, with which matter is held together.

The discovery of radio activity has furnished the means for the establishment of the fact that matter is not at all opaque. At sufficiently high velocities an atom is able to force its passage between many thousands of other atoms. Hence the modern physicist is not amazed by the observation that matter travels through the ether without forcing the latter to partake of its motion. In this, too, the insignificance of the influence of matter is made manifest. A further indication of this insignificance is furnished by the observation that, according to the findings of astronomy and geophysics, even such great masses of matter as are supplied by the sun and the earth are unable perceptibly to influence the reciprocation, called gravitation, between two particles, one located in the interior of the earth

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At This Remote Camp in the Antipodes the Einstein Theory Was Confirmed

In this crude laboratory at Wallal, an isolated oasis on the northern coast of Australia, the astronomical expedition from the University of California took the celebrated photographs of the eclipse of the sun on September 21, 1922. One of them is shown on the page facing. According to measurements made by Dr. W. W. Campbell, the newly elected president of the university, these photographs are in exact accord with the predictions of the Einstein theory.

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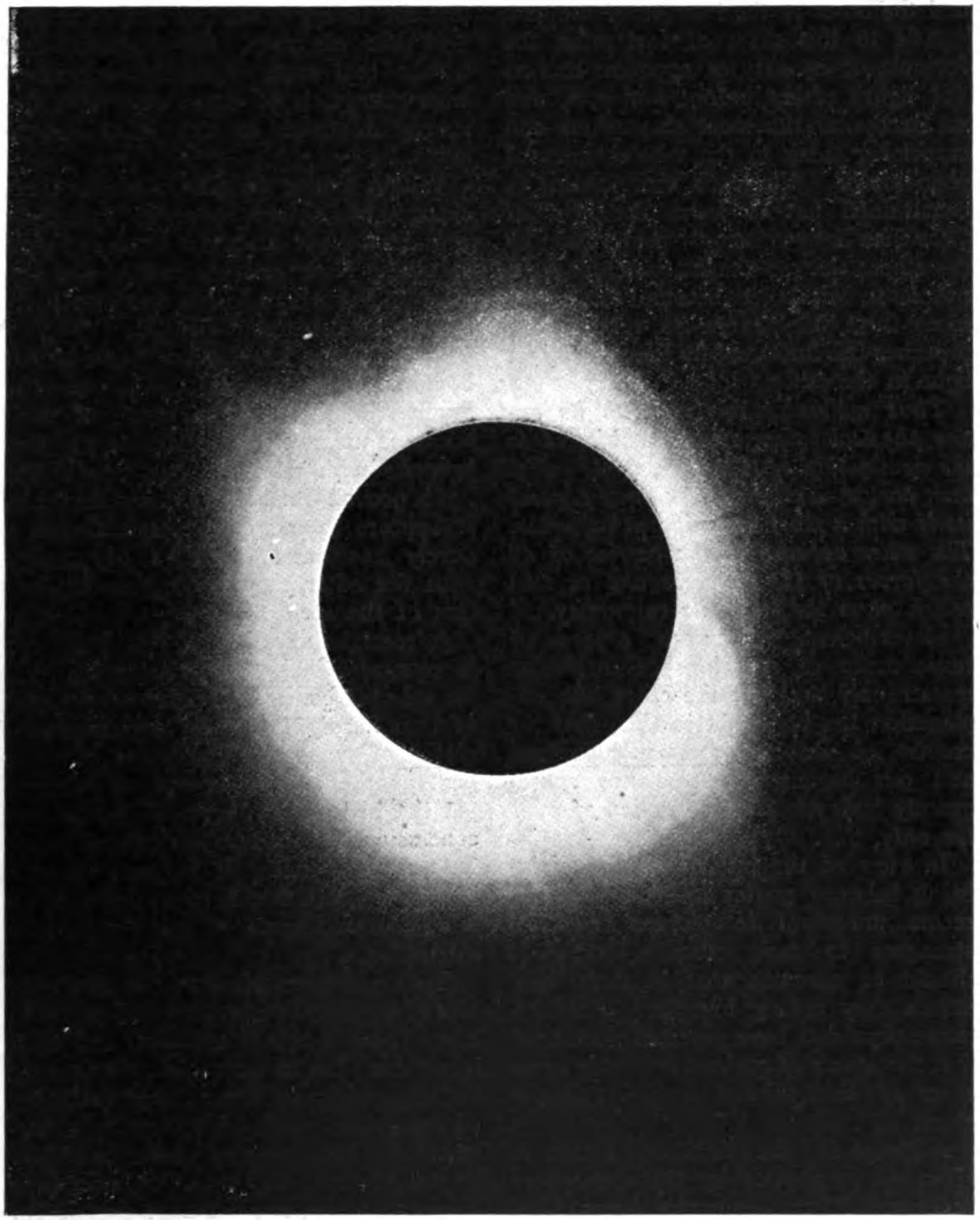

How the Sun Looks During the Moment of Total Eclipse

This photograph of the fringe of light or corona seen around the sun during a total eclipse is one of those taken at Wallal through the great forty-foot telescope shown on the opposite page. The gigantic fiery streamers of the corona, extending often more than half a million miles above the sun's surface, are visible only for the few minutes each century when the sun is in eclipse. While this issue of POPULAR RADIO *is in press scientists are gathering in California to study the eclipse of September 10, 1923, mainly in an attempt to solve the mysteries of the corona.*

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and the other in the interior of the sun.

Add to this mass of fact what the formula of equality of apparent motion (of light) places before our eyes, and we encounter the most stupendous and surprising thing in the whole realm of phenomena. We learn that matter is constrained not to leave the field of "less-than-light-velocity" prescribed by the ether; that its shapes flatten and the processes within it become more and more inert the nearer its velocity approaches the limits set by the velocity of light in the ether.

Thus molecular matter, with its entire physical being, appears subjected to the domination of the ether, while on its own part molecular matter must content itself with a most insignificant influence. The ether appears as the carrier of all the forces of the universe and as that which gives the latter its corporeity.

Nevertheless, when our organs of sense make us conscious of molecular matter only and not the ether, the explanation lies no doubt in this, *that we consist of molecular matter ourselves,* and our organs of sense are consequently *built for the observation of matter only.* . . .

In view of the intimate relations existing between matter and the ether, it seems unnatural to picture them as strangers to each other. Rather it should be assumed that in their very nature they belong together. Authoritative physicists have repeatedly asserted that *the atoms of molecular matter mark spots of distinguished condition in the ether.* . . .

A gauge for the activity of matter is given us in physics by the concept of "energy." Electro-dynamics shows plainly how this energy participates in the aggregation of matter in the ether. Hence, if we regard the atoms of matter as creations in the ether, we will have to ascribe to the ether an energy-content. And because the ether retains *within* matter all the characteristics which it displays *without,* it must be assumed that the energy which we find *in* matter —*in* the electrons, for instance—and which represents specially organized ether-energy, is of equal rank with the energy inherent in the ether generally. . . .

Within matter we note a constant exchange of energy between particles; why should not a similar exchange also be taking place between matter and the ether? It appears to me that two indications of this are discernible:

First, in the behavior of radio-active bodies. The physical cause of the gradual bursting of the atoms of such bodies is unknown to us; all the physical agencies with which we are acquainted have proved impotent to explain this. It appears to me quite possible that a purely accidental exchange of energy with the ether may effect the destruction of the atoms.

A second indication of this I believe is recognizable in the interior heat of the celestial bodies. The known sources of heat hardly suffice to account for a period of twenty million years of such heat as the sun sends out at present, yet the history of our earth forces the conclusion that the sun has existed much longer than that. It appears to me highly probable that here we have to do with a transference of ether-energy to matter. . . .

Such a view ascribes to the ether the rôle of a general reservoir of all physical life. From it this life comes, and to it it returns. Let us now think of our own bodies, which, so far as the testimony of our senses goes, are molecularly constructed. The atoms of matter form our organs of sense and even our brain (the organ to which is attributed our ability to think). But our consciousness is not divided into atoms by any means. We see connected pictures, we form connected series of impressions and thoughts. What supplies here the connection between the atoms? Evidently we must, here, as in the case of physical forces, credit the ether with the rôle of

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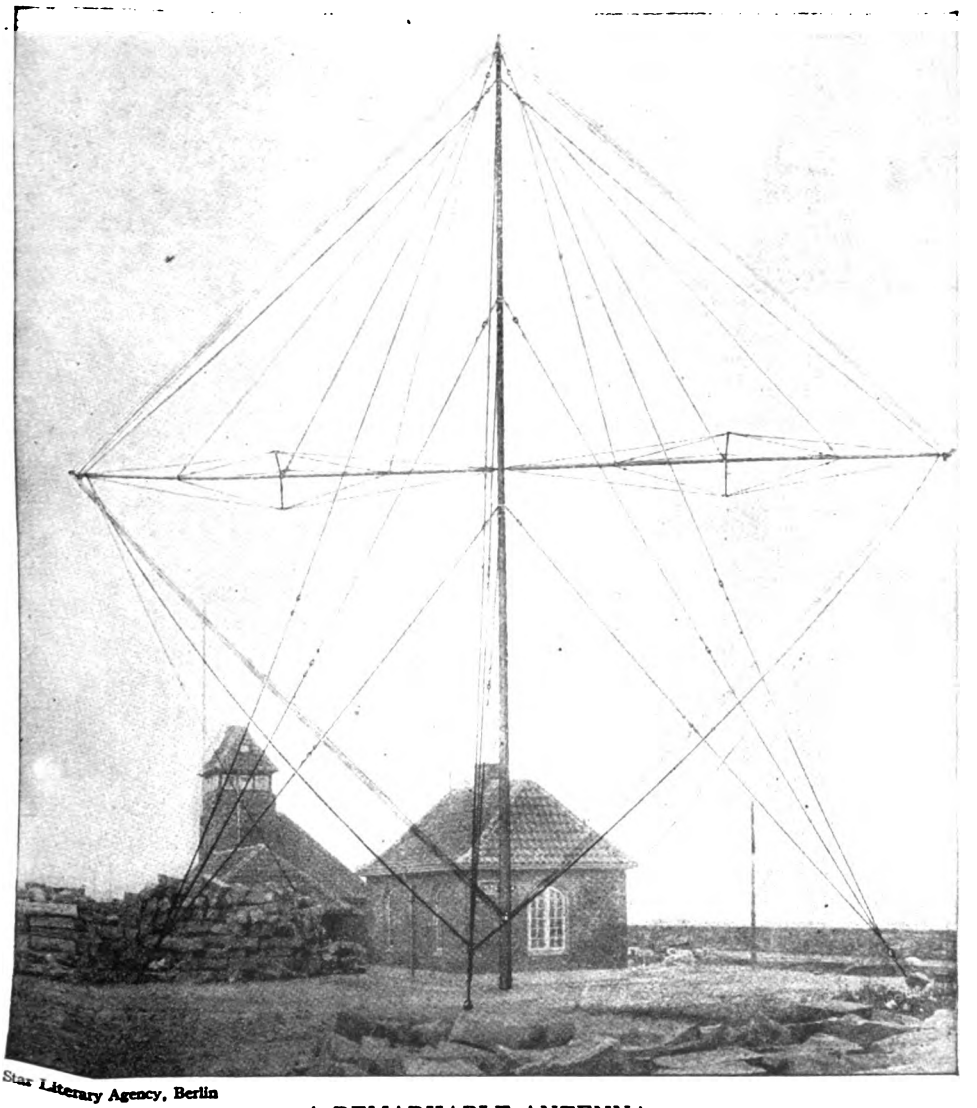
mediator. Hence for our mental life, too, does the basic substance, ether, furnish the foundation. When thus we connect our spirit with the ether, we are doing nothing more remarkable than when we associate our lives with matter, which to our senses appears to be dead.

We must free ourselves from that materialism which would accord recognition to only those things in the world which our senses show us. Beyond the world which we see there lies another world whose influence we can feel, but for the recognition of which we are most imperfectly equipped. Man is not "all-seeing" and will never become "all-knowing."



Star Literary Agency, Berlin

A REMARKABLE ANTENNA

This duplex transmitting and receiving station, situated at Ronnehafen on the Danish island of Amagar, is one of the few European stations that is capable of holding simultaneous two-way conversation.

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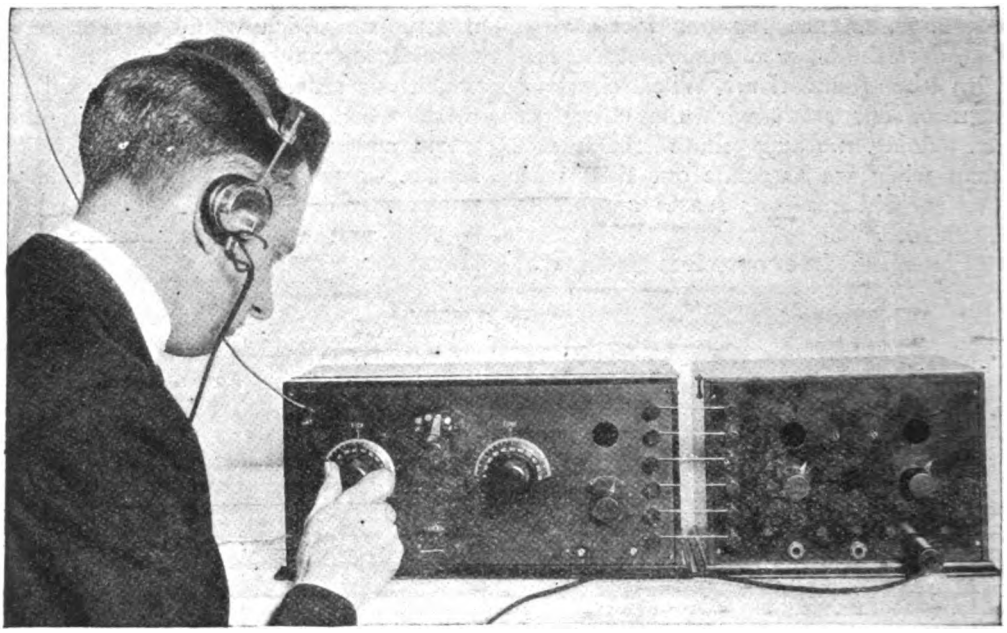

From a photograph made for POPULAR RADIO

THE COMPLETED AMPLIFIER

Here is the instrument (on the right) as it appears when connected to the tuner (on the left). It is equipped with jacks so that the detector or one or two stages of amplification may be used at will.

HOW TO MAKE A TWO-STAGE

AUDIO FREQUENCY AMPLIFIER

This instrument may be added to any set to strengthen the received signals so that they will operate a loud-speaker. The amplifier is simple to construct and efficient yet should cost no more than $15.00 for materials

BY LAURENCE M. COCKADAY, R.E.

IN the design of an amplifier for use with a detector and tuning unit, to strengthen the currents which actuate the telephone receivers, there should be four main objects aimed at. These are:

A—Maximum amplification with a specified number of tubes.

B—Minimum noticeable distortion of signal currents.

C—Amplifier should work well on all types of tubes.

D—Simplicity in construction and operation.

Due to the fact that music and voice signals have such a wide range of frequencies, it is important that the transformers have a wide range also. This means that the amplifier should have a flat curve of response and that the curve should be as high in amplitude as possible. (The curve under consideration refers to "audibility amplification" plotted against "frequency.")

Here we see that the amplifier must

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have A, at all frequencies within the audible range and so insure B; if the amplifier possessed A, at one particular frequency or band of frequencies, this frequency would be brought out and amplified more than the others and distortion would surely follow.

In the amplifier described, all these points have been incorporated by Mr. A. J. Haynes the designer; the radio fan should be able to make a first-class amplifier from these directions, with little trouble.

The amplifier was designed especially to go with the single-tube Haynes circuit receiver described in the September issue of POPULAR RADIO, which it matches in size and general design, as is shown in the photograph on this page. In this picture the cabinet at the left contains the tuning and detector unit and the cabinet at the right contains the amplifier unit.

The amplifier may be used, however, with any type of detector and with any tuning circuit that you have on hand. It will operate on the same "A" and "B" batteries that you use on your present tuning and vacuum-tube detector unit. For loudest results, however, an additional 45-volt "B" battery should be used on the amplifier.

The electrical circuit diagram is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below.

¶ *The list of parts here given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel for mounting them.

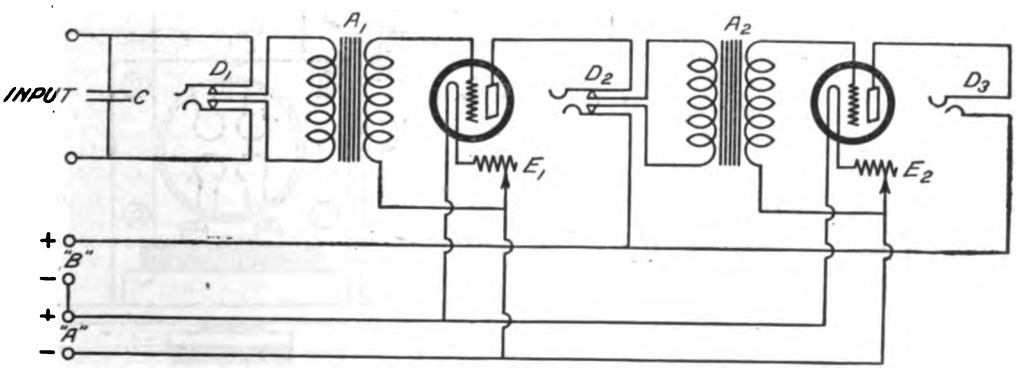
A—Ford-Mica amplifying transformers;
B—Fada panel mounting tube socket;
C—Dubilier mica fixed condenser, .002 mfd.;
D—Federal jacks, two double circuit and one single circuit;
E—Fada rheostats, 6 ohms;
F—Haynes-Griffin binding posts;
G—composition panel;
H—cabinet;
connecting wire;
varnished cambric tubing (spaghetti);
connecting tabs.

How to Construct the Amplifier

After procuring all the instruments for building the receiver, the amateur should set about preparing the panel G (shown in Figures 2, 3, 4, and 5).

First of all, the panel should be cut to the correct size (7 by 10 inches); then the edges should be squared up smoothly with a file. The center for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 4.

The holes outlined here with a double circle should be countersunk so that the flat-head ma-



THE CIRCUIT-DIAGRAM

FIGURE 1: *This gives the exact electrical connections for the apparatus used in the amplifier. The parts are designated by letters which correspond to those used in the text and in the other diagrams and illustrations.*

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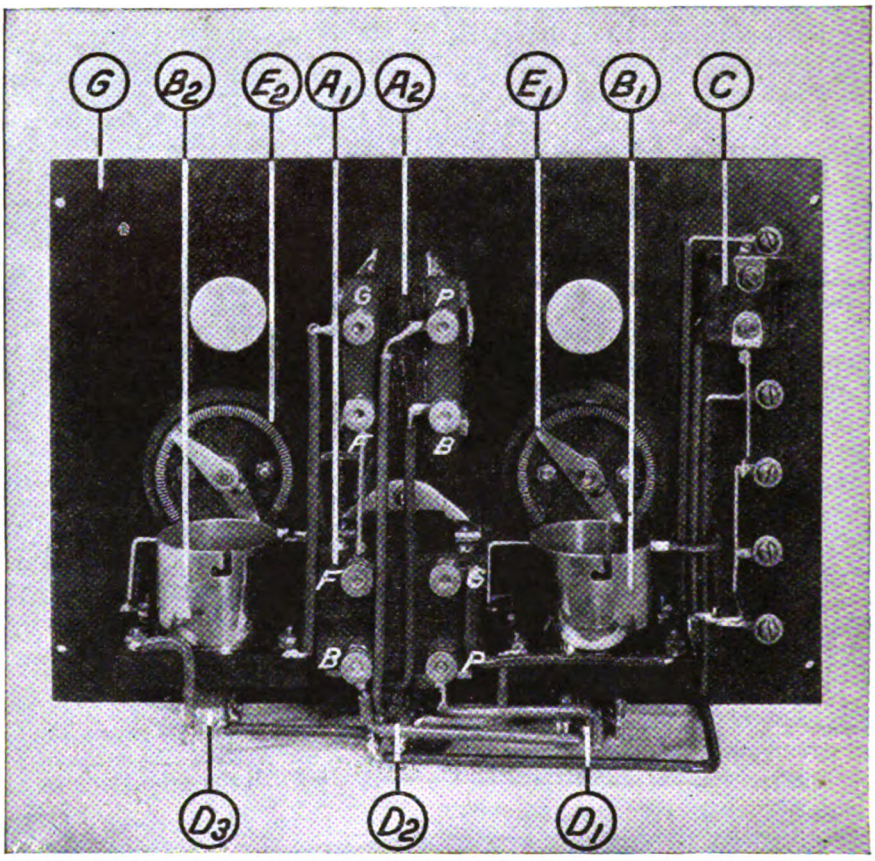

FIGURE 2: *This picture shows the interior arrangement of the apparatus, together with the general locations for the sockets, rheostats, transformers, jacks, condenser and the binding posts.*

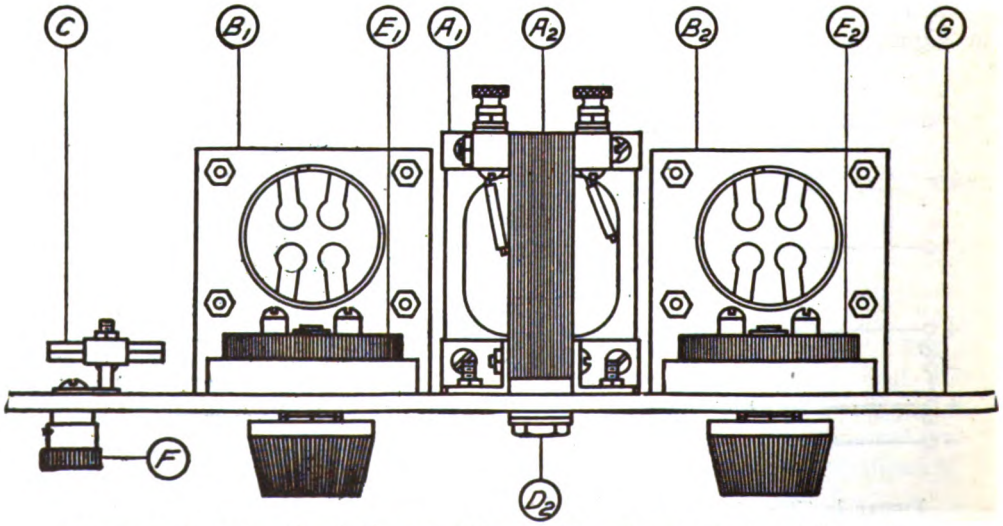

FIGURE 3: *A constructional drawing of the amplifier, showing the layout from above. Notice that the transformers are mounted at right angles to each other.*

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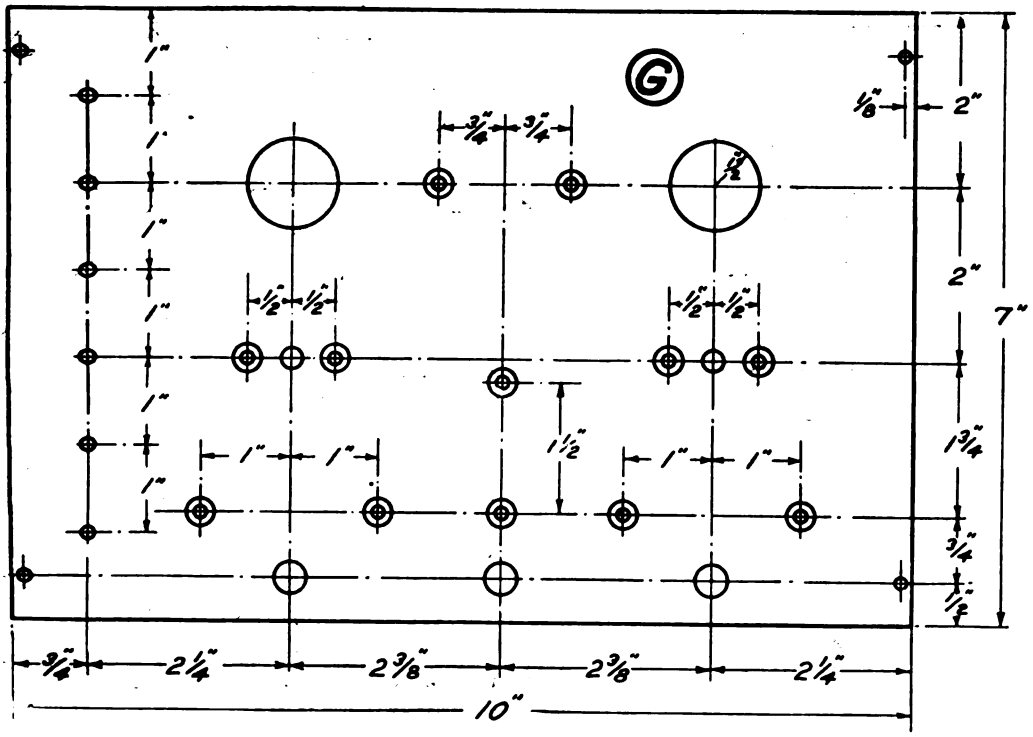

HOW TO DRILL AND CUT THE PANEL

FIGURE 4: *This diagram gives the correct locations for the holes for the instruments and the binding posts. The holes outlined here with a double circle should be countersunk; the rest of the holes are straight drill holes.*

chine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next the two transformers A, should be mounted as shown in Figures 2, 3 and 5, so that the letters beside the connection posts correspond to those of the photograph in Figure 2. The transformers are fastened to the panel G, by two screws to each transformer. The screws are inserted through the holes in the panel and through the brackets on the bottom of the transformers and fastened with hexagon nuts.

Three telephone jacks are used, which allow the phones or loudspeaker to be plugged in on either the detector, first or second stage of amplification as desired.

It will be noted that two of the jacks, D1 and D2, are double circuit; that is, with four spring leaves and connection points, while the third, D3, is a single circuit jack with only two connections on it. The latter is for use in the last stage of the amplifier, while the former are used for the detector and first step.

These should be fastened to the panel G, in their respective positions as shown in Figures 2 and 5. It will be noticed that they are mounted sidewise instead of in the regular up and down position. This is necessary so that they will not interfere with the cabinet.

Now mount the two rheostats E, using two screws to each rheostat, as shown in Figures 3 and 5, and adjust the spring levers with the correct tension so that they run smoothly.

Then fasten the two tube sockets B, to the panel with flat-head screws as indicated in Figures 2, 3 and 5, and the construction work on the set will be complete.

The condenser C, is supported by the wiring and may be left until that job is in process.

How to Wire the Amplifier

The constructional design of this piece of apparatus is such that the circuit wiring may

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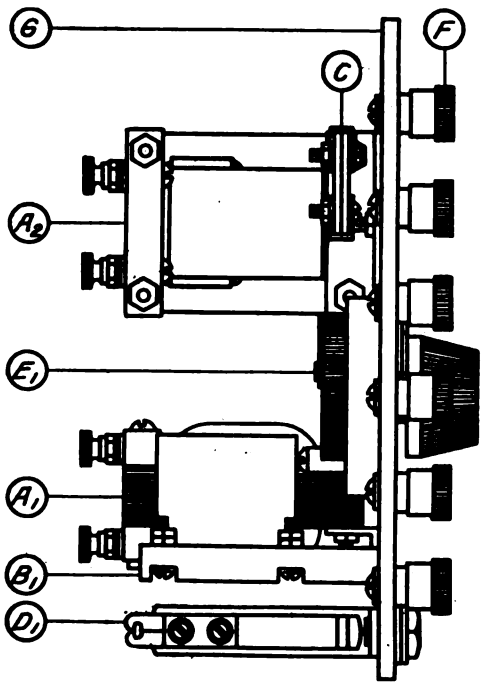


THE WORKING DRAWING OF THE SIDE ELEVATION

FIGURE 5: *The jacks are mounted on the lower part of the panel with the two transformers taking up the center section. The binding posts are arranged in a vertical line at the left edge of the panel.*

be made as short as possible. This will be evident from an inspection of the photograph in Figure 2.

With the wiring diagram in Figure 1 before you, start wiring up the primary circuit of the first transformer, including the two top input binding posts, the condenser C, the terminals of the jack D1, and the two terminals of the transformer which are marked "B" and "P."

Then wire the filament circuit of the two tubes, including the rheostats, the two terminals of the sockets marked "F," the terminals of the transformers marked "F," and the two lower binding posts, the lowest of which is the negative "A" battery connection and the other is the positive "A."

The third binding post from the bottom is for the negative "B" and it should be connected to the same wire as the second binding post from the bottom, the positive "A."

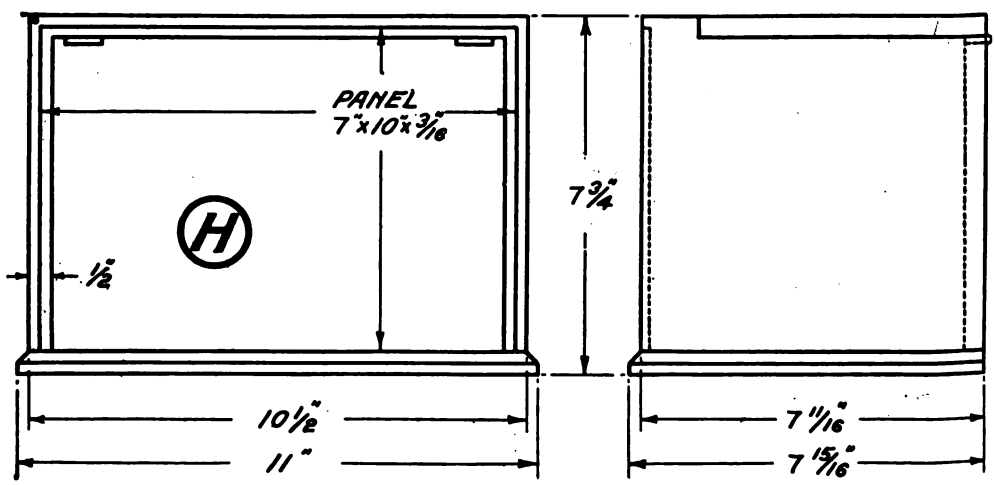
Now connect the post "G," on the first transformer to the grid terminal of the first tube.

Then, connect up the third binding post from the top, the positive "B" battery post, with the jacks D2 and D3, and wire the plate circuit of the first tube which includes the terminals on the jack D2 and the terminals on the second transformer "B" and "P."

Finish up by connecting the terminal "G" on the last transformer to the grid terminal of the last tube, and by connecting the plate terminal of the last tube to the jack D3, as shown.

Operating Data

The operation of this amplifier is extremely simple. It is connected to the receiver merely by bridging the binding posts straight across from the tuner and detector panel to the amplifier with the exception of the two "B" battery posts. When the same "A" and "B" batteries are used for both sets, as is almost invariably



THE DIMENSIONS OF THE CABINET

This may be made by the builder himself, or the plan may be turned over to a cabinet maker. The woodwork may be done in any kind of hardwood that conforms to the owner's taste.

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done, the "B" negative post of the amplifier is left disconnected altogether. The 45-volt "B" battery should be added to the 22½-volt "B" battery already in use for the detector, the negative post of the 45-volt battery being connected to the positive 22½-volt post of the smaller battery and the positive 45-volt post on the large battery is connected directly to the "B" positive post on the amplifier panel. The original connections from the 22½-volt "B" battery to the detector being left exactly as previously connected.

This arrangement allows the small battery to be used with the detector while the full voltage of both batteries, 67½ volts, is applied to the amplifier tubes.

To put the amplifier into operation place the telephone plug into the first, second or third jack, depending on whether you wish to listen in on the detector alone, the first or the second stage of amplification, and turn up the rheostats to the proper value.

The tubes should be burned as low as possible without impairing the signal strength or quality. Turning on the rheostats beyond this maximum point will only shorten the life of the tube.

If the receiver is tuned to a signal, the amplifier should immediately begin to work and produce a strong signal that will operate a loudspeaker successfully on the second stage.

Ten Good Rules for Broadcast Listeners

1. Don't try to hear DX till cold weather. Be satisfied to enjoy the nearer stations most of the time.

2. Don't be disappointed if an occasional storm interferes with your autumn radio evening. There are many fine concerts coming. You can't expect to find a pearl in every oyster nor to receive a record-breaking concert every night.

3. If you want louder signals, use a longer antenna, more tubes, higher plate voltage, more sensitive loudspeakers, and more careful tickler and receiver adjustment.

4. A pleasant signal filling a moderate sized room should be enough to give satisfaction. It is not worth while producing signals which deafen the neighbors. It is wasteful to insist on tremendous signals which are generally less pleasant than moderate signals.

5. If your local station comes in too loudly and drowns others out, a smaller antenna will help in tuning him out, with a smaller condenser connected between antenna and ground. And if all measures to get rid of the local station fail, why not enjoy his concerts? He is working hard for you and it is nobody's fault that you are so close to him that you are bound to hear him. Broadcast stations have to be closer to some people than to others.

6. For the new longer waves above 450 meters, use a condenser connected between the antenna and ground terminals of your set.

7. A little patience in learning to handle your receiver yields rich returns in satisfaction from fine signals. Remember that "Rome wasn't built in a day" and keep on getting more and more familiar with your set and how it works.

8. It is a good idea to read POPULAR RADIO and the radio column of a newspaper or two. It helps you to know how your set works and keeps you up-to-date in radio. Information of this sort is an aid in getting the concerts loud and clear.

9. Ask your radio dealer for advice; he can probably tell you what you want to know and will be glad to do so. The manufacturer of your set is also willing to help you get the desired results from its use.

10. Do not throw away the direction sheets or booklet that came with your set and with the tubes. Read all such material carefully now and then. If you have lost the direction sheets, write to the dealer or manufacturer for another. The direction sheets must answer most of the questions which have been puzzling you and preventing you from getting the best out of your set.

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WHY DOUGLAS FAIRBANKS SMILES

"The public doesn't care a whoop who plays the parts; it is interested only in the story," claimed one astute producer thirteen years ago—when the public's early interest in the movies was where the interest is in broadcasting today.

Who Will Be the Mary Pickfords of Radio?

Will the new art of radio create its own stars who will shine in the new world of the ether that is rapidly being opened?

By WILLIAM G. SHEPHERD

A PROMINENT editor, thirteen years ago, was coaxed to go into a movie theater to see the crude film of the day. No one thought it was crude then, of course. The photography was spotted and bad, the acting was poor, and no one in these days would sit five minutes before such a picture. But the editor, like the rest of us, did not know any better—and he became a movie fan.

One day this editor called me into his office.

"Who are all these actors and actresses whose pictures appear in the cinematograph films?" he asked me.

"I don't know," I said. "I've never seen their names printed."

"Well," said the editor, deliberately—

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and remember, please, that this was only thirteen years ago—"I want you to go out and get me photographs and little life stories of about two dozen cinematograph actors. I think the public will be interested in the personalities of the actors who appear on the films."

So I started out. I went to the office of a man who then headed a firm that has since become one of the greatest in the moving picture world. I told him that my editor wanted to run a photograph and a little life-story sketch of every one of the men, women and children who then appeared in his films.

"These stories will interest our readers," I explained, "and they will advertise your players."

"Advertise blankety-blank blank," he yelled, that afternoon thirteen years ago. "We don't want our players advertised."

"Why not?" I insisted. "There'll be no cost or trouble for you. I'll send a staff photographer to the actors and actresses and I'll get their stories myself. It won't bother you in the least and it will be telling the public something about the people who are playing in your films."

Westinghouse

A BIG STAR ON THE CONCERT PLATFORM IS NOT ALWAYS SUCCESSFUL IN BROADCASTING

Some voices do not broadcast—they literally cannot be transmitted successfully by the microphone. Madame Lucilla Melius, the grand opera singer, is fortunate in that she charms the invisible radio audience just as much as those who actually hear her in a concert or in an opera.

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American Tel. & Tel.

THE ARTIST IN THE WORLD OF RADIO MUST DEPEND UPON HIS MUSIC ALONE

When Guy Hunter, the popular blind pianist, plays to his invisible audience, he cannot resort to mannerisms, stage tricks, settings or other conventional accessories for "putting over" his recital. Will not these very limitations tend to raise the art of the broadcaster to a high level?

"The public doesn't give a whoop who plays in my films. It doesn't care for anything but the story and the film. The actors are only actors to them and nothing more."

I didn't know whether he was right or wrong; the movie game was too new for an outsider or even an insider to judge.

That man got really mad before I got through with him. (Today, as I say, he is one of the biggest men in the business and, of course, has spent millions of dollars in advertising.) Finally I pinned him down to his actual objection to publicity for his players.

"Look here, young fellow," he said, "here's the truth about it. Every film maker in the business is looking for all the good actors and actresses he can find.

"Do you suppose after I've found an actor or an actress that everybody likes that I'm going to put a picture in the paper and advertise my find to all the other moving picture men? Why, we'd get to trying to outbid each other for the stars, and the first thing we knew the moving picture business would go up in smoke. No, sir, I'm going to keep all my stars a secret just as long as I can and I don't want their pictures or write-ups about them in the newspapers."

Gentle radio fan, can you beat that?

But my editor had sent me out on a job and I had to produce something. That evening I was telling my troubles to a man named Hullette, an old star newspaperman on Park Row, New York.

"Why, I think I can help you out on that stunt," he said. "My daughter, Gladys, is in a moving picture that is being staged in an old barn over on Long Island. She's only twelve years old, but she's taking a prominent child's part. I'll ask her tonight if she can't get you the names and addresses of the people she's playing with. That'll be a bargain, if you will put Gladys' picture in the paper

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with a little write-up like the rest."

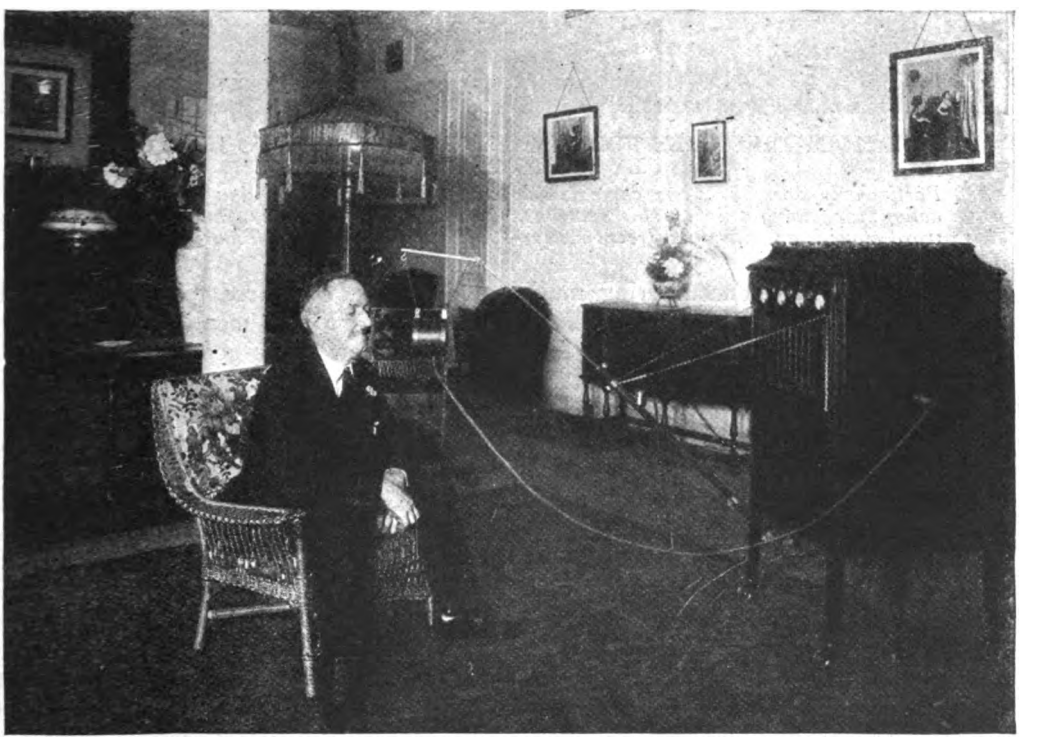
"It's done," I replied.

Gladys Hullette is a famous movie star these days, but perhaps she'll remember how, thirteen years ago, she sneaked around among those moving picture people over on Long Island and asked for their names and addresses and told them that a newspaperman wanted their pictures and a little write-up of each one. She turned over some twenty or thirty addresses to her father, who brought them to me.

It was a three weeks' job to meet these people and get their photographs and stories. Needless to say, most of them were hungry for publicity.

Those twenty-five sketches of moving picture actors and actresses were the first of the sort ever published in the United States. The manager threatened to sue the newspaper for making public the names of his players. Yet, as I have said, he has spent millions of dollars in advertising his stars since that day; has had many of his stars coaxed away from him, and has coaxed as many more away from his competitors.

He was one of the longest-headed men in the moving picture business, but he couldn't tell what a score of months would bring forth. He did not see how business was heading or what form it would take. He was on an unblazed trail. Within two years after I had so ungraciously offended him by my unwelcome publicity "stunt," he was paying money for advertising and had a press agent who was trying to sneak items into the newspapers of the country.



Westinghouse

ONE OF THE MOST POPULAR OF THE "STARS" IN THE NEW RADIO FIRMAMENT

Hundreds of thousands of American youngsters will grow up and carry with them fond memories of the famous bedtime stories of David Corey, whose "Peter Rabbit" adventures were reckoned among the important features from the earliest days of broadcasting.

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THE MOST DIFFICULT FORM OF ENTERTAINMENT TO "GET OVER" BY RADIO IS HUMOR

Particularly does the stage comedian depend upon facial expression and physical action for giving point to his remarks. But fun that depends upon the spoken word alone is an entirely different matter—as the comedian Frank Tinney is learning.

So today we are encountering much the same problem in another field. Wireless telephony now is even younger than was the moving picture business at the time that I offered free advertising to the moving picture stars. There isn't a man in the wireless telephony business who is any smarter or any more long-headed than my friend of the movies.

They don't know, even the wisest of them—though some of them may think they do—how widely broadcasting is going to develop and what direction it will take. As for seeing its maximum limits, they are stone blind; it is beyond human power for them to follow with their thought the great sweep and progress of radio.

At present there are men in the United States wondering whether or not the wireless telephone will do away with newspapers, the wired telegraph, or the telephone. Many men are wondering not only how much good it will do, but how much it will change things in this ever-changing world of ours—and what things it will change. Will it hurt the movies? Would people rather sit at home of a summer evening and listen to concerts than to ride in their automobiles? Will it hurt the passenger car industry? Will it leave the churches with empty pews? Will it increase the size of sermon audiences? Will it bring the end of the talking machine? These and many other questions cannot be answered yet with any more truth than were mine about advertising movie stars such a short time past.

The movie eventually fitted into every department of our lives. It found its way into the laboratories and into the

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very heart of science. It found its way into war and it has furnished us a new art. The wireless telephone will likewise find its true place and will have its part in our daily lives; though how, even the wisest among us cannot tell.

The time will come, indeed, when the free broadcasting of concerts and entertainments will come to an end. I believe the man who denies this is as far at sea as was my movie friend. The day will come when only the most mediocre artists will sing, free of charge, into a transmitter. The day will also come when broadcasting audiences will demand far greater merit in performances than they often discover in these early, crude days. These are the spotted film days of broadcasting. Undoubtedly new forms of entertainment, appealing to the sense of hearing, will be developed. You know that only the most beautiful of the world's singers find their way to the operatic or concert stage; they must appeal as much to the eye as to the ear. How many thousands of exquisite singers never find their way into public favor?

But the broadcasting audience asks only a beautiful voice; however beautiful and gracious the singer may be at the broadcasting end of the line, this audience is taking the music to its heart through the ears alone. If the music be beautiful and appealing, that is all the radio public asks.

Is it not possible that we shall develop in the United States artists who will sing for broadcasting alone—singers with voices especially adapted to broadcasting—readers of poetry or fiction, with golden voices, for the sick or the leisurely or the lovers of literature?

Now we have our free entertainments which show us the wonders of wireless telephony and persuade us to buy receiving sets. The American people are taking these machines almost faster than they can be made. The time is coming soon when the owners of receiving sets will be asking for something better in the form of entertainment than they are receiving now. Some will ask an evening of classical music; others may want to hear poetry or the latest book; some will call for a program of dance music, and some for addresses from well-known men on live topics of the day.

We Americans have all kinds of tastes. We shall show this, soon, in the world of wireless entertainment. And then the entertainment givers of today will have to step out of the way and permit the impresarios of radio entertainment, the men who control the great radio stars and pay them heavy salaries, to have their radio way. We shall probably have meters on our receivers which will show to whom we listened and when. Then will come the day of the Mary Pickfords and the Douglas Fairbankses of broadcasting; and we shall be watching the programs for the days when they will perform and at what stations they will sing, read, lecture or just talk. Also we shall probably be ready to pay more money to hear the good artists than the lesser ones. Now we have our stars of the movies, our stars of baseball, of lawn tennis and of football. Soon we shall have, too, our stars of the radio.

As a mere means of entertainment it is impossible to measure the limits of wireless telephony. It is even more impossible to surmise what place wireless telephony will take in our daily lives. We must learn to use it as we learned how to use the telephone, the telegraph, or, in olden days, the postage stamp.

How to Build a Combination Short and Long Wave Receiver

In the next number of POPULAR RADIO—for November—will appear a complete detailed description of a set that combines the advantages of a three-coil honeycomb tuner for long waves with the advantages of the variocoupler, two-variometer regenerative tuner for short waves.

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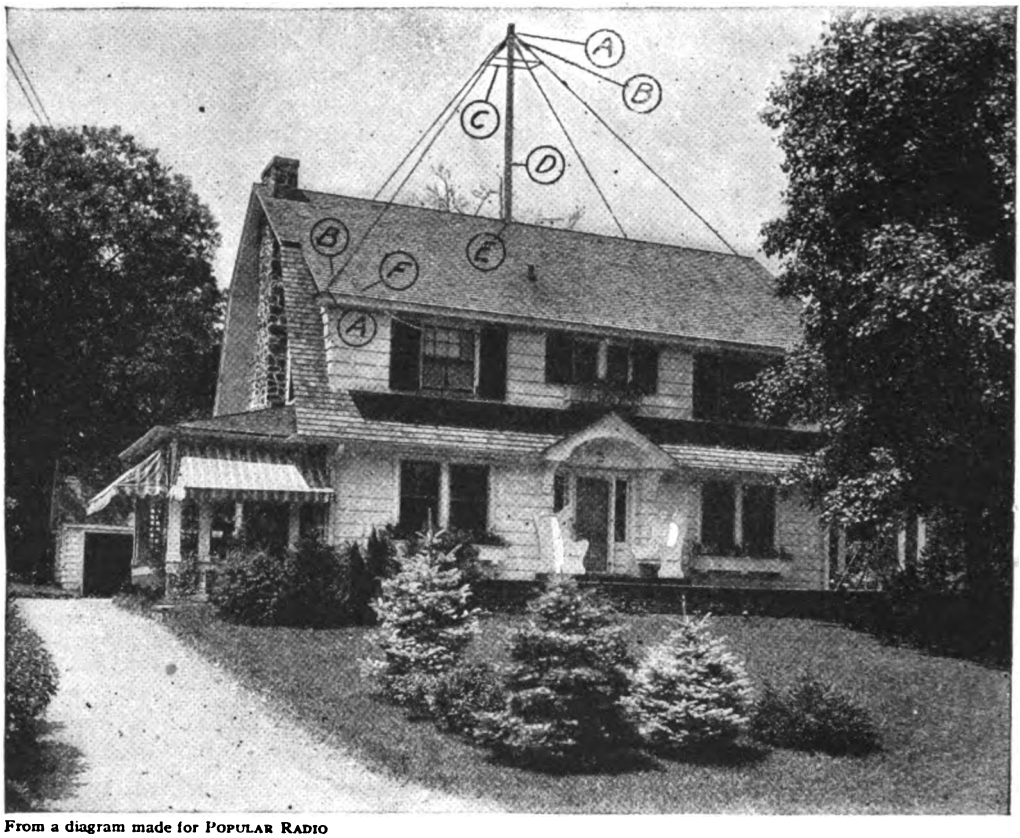

From a diagram made for POPULAR RADIO

THIS ANTENNA DOES NOT ENCROACH ON YOUR NEIGHBOR'S PROPERTY

The parts designated are: A, the insulators (8 are required); B, the screw-eyes of the insulators through which the wires are fastened; C, the bonding wires; D, the mast which is cut in a V-shape at E, to fit the ridgepole, and F, the lead-in wire which may be attached to any of the sloping wires which run near the window which is nearest the instruments.

A Compact Antenna

THE UMBRELLA TYPE

The Fifth of a Series of Short Articles on the Various Types of Aerials and Their Uses

By HOWARD S. PYLE,* I.R.E.

MANY articles have appeared lately in the various periodicals, relative to antennas suitable for broadcast reception. The chief difficulty with most of those that have been considered, however, lies in the fact that to be really effective they require a length (in a single span) so great that in ninety percent of the cases it is necessary to carry the wires outside of the property of the owner.

There is a considerable reticence among owners of receiving equipment to ask their neighbor for permission to use his chimney or tree as a sup-

*Assistant U. S. Radio Inspector, 8th Radio District.

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port for one end of their antenna. The larger majority of people much prefer to confine the antenna to their own property lines.

For this purpose, the writer has conducted experiments with one of the earlier types of antenna, the famous "umbrella type," which adapts itself readily to a small space. Since 1901 it has been a standard with the U. S. Army Signal Corps, not only in the field but in some of the permanently established stations.

This antenna derives its name from the resemblance it bears to an opened umbrella—without, of course, the customary cloth covering.

A mast or pole is erected in the middle of the space over which it is desired to erect the antenna proper, and from the top of the mast wires are run in the same manner as guy wires to each of the four corners of the building on which the pole is set. In fact, these wires act as guy wires, serving to hold the mast rigidly in place. They serve a dual purpose, however, inasmuch as they are insulated both from the mast and from the ground, and are all electrically connected together to form the antenna proper.

Umbrella antennas have proved to be very effective; they have one particular advantage in that they are *non-directional:* that is, they receive signals equally well from all directions.

For installation in the average case, it is recommended that a pole ten feet high and two inches in diameter be erected in the exact center of the roof of the building, and painted or stained, for appearance sake. Four suitable antenna insulators are secured to the top of the pole by short pieces of antenna wire through small holes bored in the mast, or by heavy screw eyes; one in each side near the top of the mast. A V-shaped notch is cut in the bottom of the pole, to fit the ridge pole, to which it may be secured with a few nails. One strand of antenna wire is then secured to the free end of each of the insulators attached to the pole, and carried to each of the four corners of the roof, where they are secured after being connected to another insulator just above the point of attachment.

Before raising the mast, the four strands should be electrically connected together at the top just below the insulators, by binding a piece of antenna wire around each wire, forming a loop around all four. The joints should be carefully soldered. Where the roof is not broken by obstructions, such as dormer windows, skylights or chimneys, it is well to connect the wires together at the base also, just above the lower insulators by passing a bonding wire completely around the edge of the roof, soldered to each strand of the antenna proper.

The lead-in may be taken from any of the four wires, convenient to the point of installation of the set, or at any point along the lower bonding wire, where used.

Such an antenna permits of excellent reception, keeps the entire arrangement on the radio enthusiast's own property, and presents a neat, inconspicuous appearance. The writer, in Cincinnati, experienced no difficulty in picking up the broadcasting from Kansas City in broad daylight, using a single stage of audio frequency amplification with a standard regenerative receiver, which speaks well for results.

How to Use the Four-circuit Tuner as a Portable Set With a Loop Aerial

A clever modification of the famous Cockaday receiver that gives satisfaction with local reception will be described in the coming—November—number.

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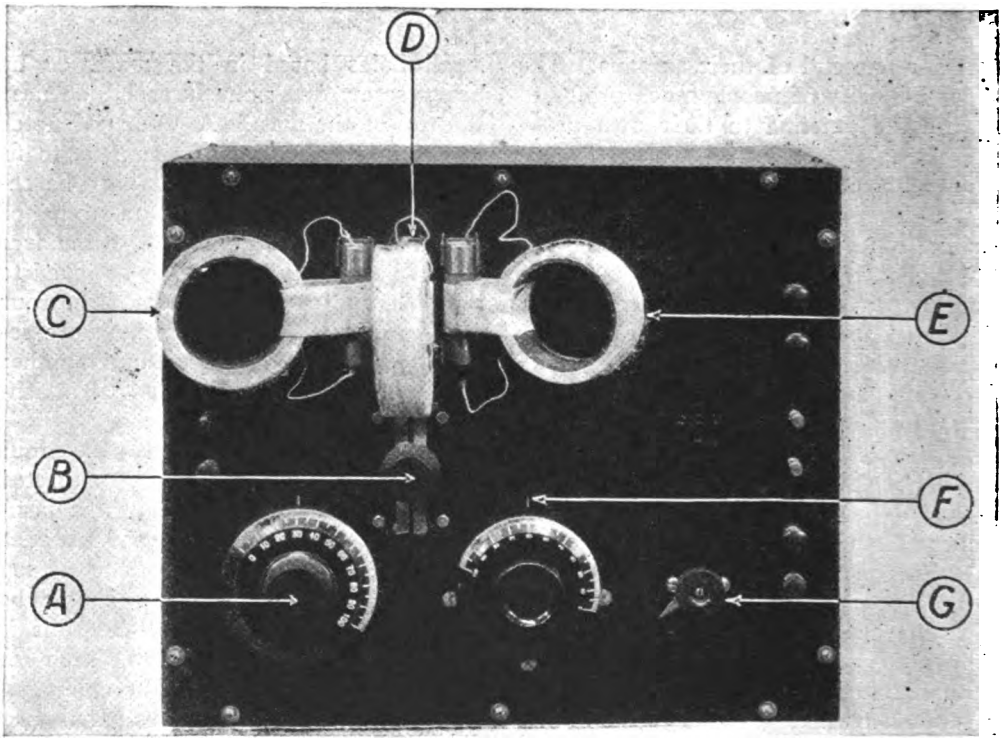

THE PANEL VIEW OF THE COMPLETED RECEIVER

FIGURE 1: *A, is the primary condenser, B, is the series-parallel switch, C, is the primary coil and D, and E, are the secondary and tickler coils respectively. F, is the secondary condenser and G, is the rheostat.*

HOW TO MAKE

A Simple Honeycomb Receiver

A complete description of a simple method for making your own honeycomb coils at home and also how to build a receiving set that accommodates them and enables reception on all wavelengths between 200 and 3,000 meters. The complete equipment should not cost more than $15.

By S. GORDON TAYLOR

WHEN the use of home-made honeycomb coils is suggested to the amateur he usually passes the matter up with a shrug. His reasons are these:

First, he does not believe that honeycomb coils can be made at home by the average amateur.

Second, he considers that the cost of a set of coils sufficient to cover a broad band of wavelengths is out of reach of his pocketbook.

In direct contradiction to these beliefs, however, is the fact that I have made a set of honeycomb coils at home and at a surprisingly low cost. Furthermore, they were made without special equipment and the work was done in a short period of time.

There has been prevalent an idea that honeycombs are of little use on the broadcasting wavelengths around 360 to 400 meters. This belief, however, is not

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based on fact. Perhaps the honeycombs *are* less efficient on short waves than some other types of sets, but in actual practice I have not been able to notice the difference. Station WJZ, thirty miles away comes crashing in so loud on the detector tube alone, that I can hear him ten feet away with the phones lying on the table; with one stage of amplification and using the phones I can hear him three rooms away. Then again, distant stations come in with surprising clearness on one tube. This is equal to or better than anything I have been able to do with other types of regenerative sets.

But a great advantage of the honeycomb set over others is that it is capable of covering any wavelength desired. For one who reads code, or wants to learn, this is a decided advantage.

The honeycomb set I made at home is simple in construction. In Figure 1 the complete set is shown mounted in a cabinet. Coils suitable for reception on 3,000 meters are in position. The first dial on the left is the primary variable condenser. The series-parallel switch, just above it to the right, is used to throw the condenser in series or parallel with the primary coil, or to cut it out entirely. To the right of the primary condenser is another variable condenser, shunted across the secondary coil. Next comes the rheostat knob, and on the right hand edge the connections for receivers and "A" and "B" batteries. Incidently, I am using a WD-11 tube requiring only 1½ volts on the filament. With the storage battery thus eliminated the "A" and "B" batteries may be mounted in the cabinet, making the outfit entirely self-contained and portable.

There should be no difficulty in winding the coils; a 25-turn coil can be wound and mounted on a plug in about fifteen minutes, while a 250-turn coil can be completed in an hour. From this it is obvious that the job is not a complicated one.

The eight coils selected are enough for ordinary use and cover all wavelengths from about 200 up to slightly over 3,000. They consist of the following numbers of turns; 25, 35, 50, 75, 100, 150, 200 and 250. Larger coils may be made but I have adopted this set as a standard on which to base the list of materials needed and the cost.

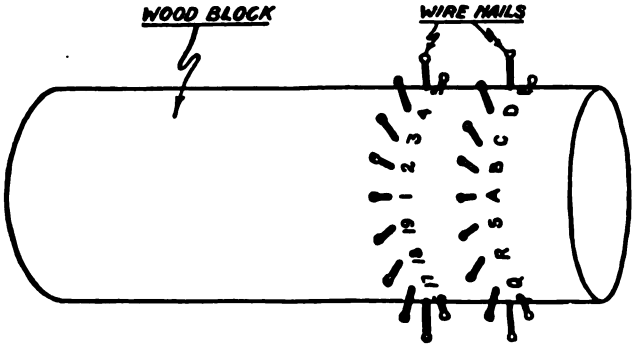
The following table shows the materials needed for winding eight coils, together with the costs:

Winding form

One cylindrical wooden block, about 2 inches in diameter; length optional, but preferably about 8 inches;
38 wire nails 1¼ inches long.....$ .05

Coils

One cardboard tube, 7 inches long, and



THE COIL-WINDING BLOCK

FIGURE 2: *The wire is wound lattice fashion between two rows of nails driven into the periphery of the circular block. All the coils specified are wound on the same block and differ in dimensions only in the number of layers of wire used.*

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just large enough to slip snugly over the wood cylinder	.10
¾ pound No. 26 DCC copper wire	1.20
5-yard roll of 1-inch adhesive tape	.25
small bottle of white shellac	.25
Plugs and plug mounting	
One rectangular wooden block, 8x1x⅞ inches;	
8 cartridge fuses, 2½ long by ⅝ inches in diameter	1.20
Panel mounting	
6 fuse clips to fit above fuses	.18
Total cost	$3.23

How to Make the Winding Form

The first step is to make the winding form. Once this has been done the form can be used indefinitely for winding as many coils as desired. The wooden cylinder and the nails are used for this purpose. The location of the nails on the surface of the cylinder is best determined by the use of a piece of paper, cut so that its length equals the circumference of the cylinder.

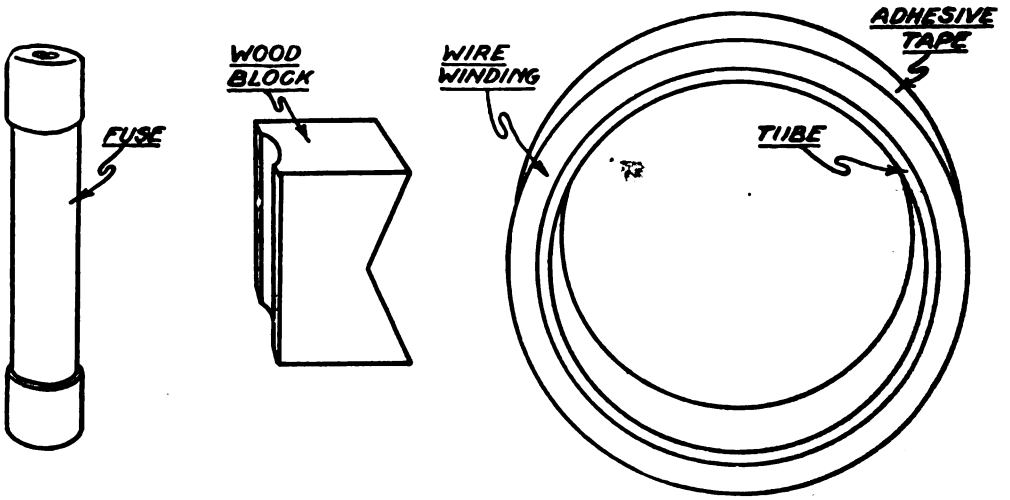
On this paper draw lengthwise two parallel lines, ⅞ of an inch apart. Beginning at one end of the paper, divide each line into nineteen equal parts indicated by dots or short lines. When this has been done place the paper around the block so that the two ends of each line will just meet. With a pin, prick a hole through each of the dots on the paper and into the wood so that when the paper is removed these pin pricks will appear on the cylinder in two parallel rows around the circumference. It is best to have these near one end of the cylinder for later convenience in handling when winding the coils. Drive a wire nail a short distance into each pin prick, say about one-quarter inch. The nails should hold securely but be easy to remove with a pair of pliers. It is important that the nails are driven directly toward the centre of the block, and that each is at right angles to the axis of the block. Figure 2 shows the winding form complete and ready for use.

For convenience in winding the coils it is well to number the points at which the nails are driven. Start with any nail and mark it No. 1, the next one in the same row No. 2, and so on. These numbers will run up to No. 19. Mark the other row in the same way, but use letters instead of numbers, starting with the nail opposite No. 1 and marking it "A," marking the one opposite No. 2 as "B," and so on.

How to Prepare and Wind the Coils

The cardboard tubing should be cut into ⅞-inch lengths. Eight of these pieces should be cut, one for each coil that is to be wound. Two coats of shellac should be applied to each, to make them proof against dampness, and also for greater stiffness. When they are thoroughly dry place one on the wooden cylinder between the rows of nails by removing one row, slipping the tube on the cylinder and replacing the nails.

Everything is now in readiness for the actual winding. Let us assume that the 25-turn coil is the first to be wound. Starting with the free end of the wire outside of the rows of nails take a couple of turns around 1, so as to hold the wire secure. From 1, the wire passes diagonally across the tube to "K," out around this nail and continuing in the same direction, but crossing diagonally back to the other side of the tube to 2. When this has been done it will be noticed



THE FUSE, THE BLOCK AND THE COIL

FIRURE 3: *Just before these units are assembled the three parts are brought together and fastened with adhesive tape. The two ends of the coil are then soldered to the two metal ends of the fuse.*

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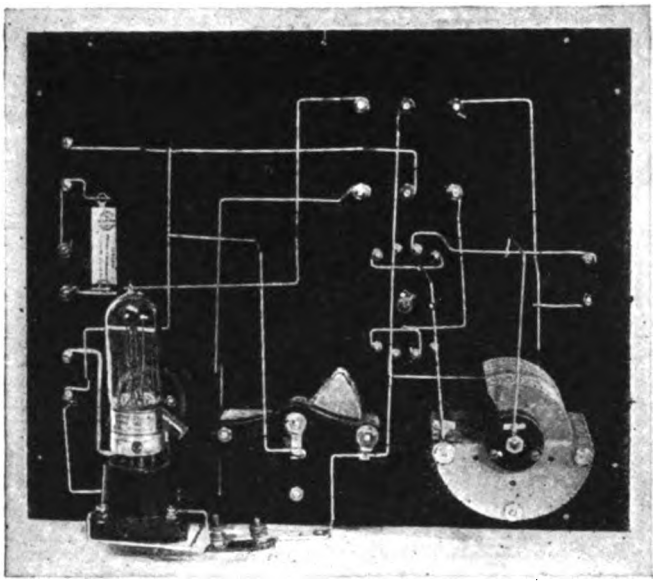
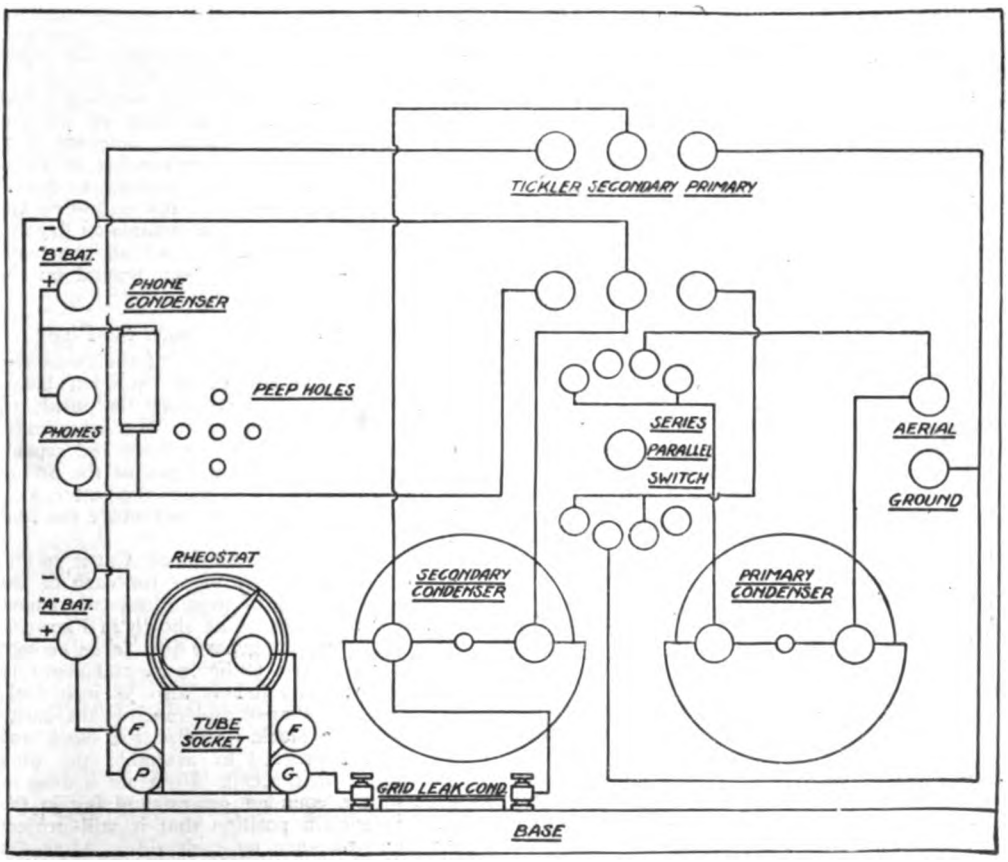
HOW THE SET SHOULD BE WIRED

FIGURE 4: *The photograph at the right shows the interior arrangement of the instruments and the wiring, which should help in connecting up the set. The diagram at the bottom of the page, however, gives a clearer idea of the connections; between the two, even the greenest novice should have no difficulty in wiring up correctly.*





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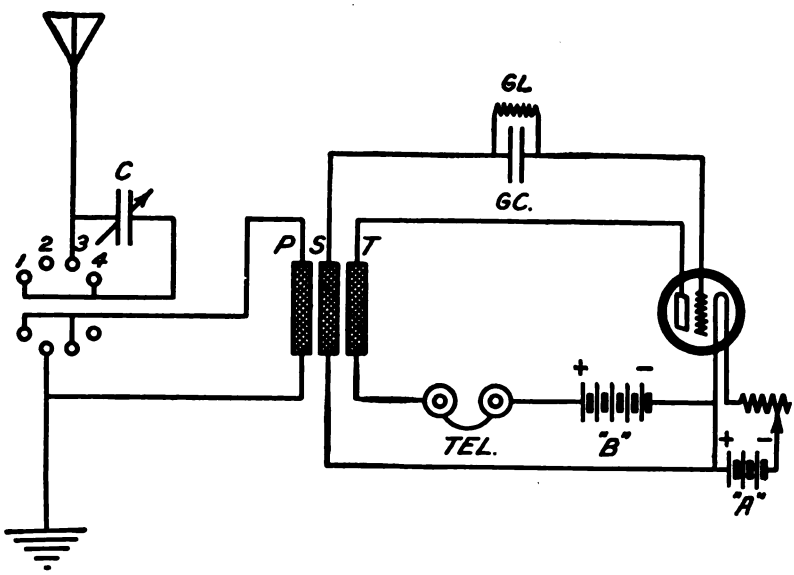

THE ELECTRICAL DIAGRAM OF THE CONNECTIONS

Here is the regular wiring circuit that shows how the various instruments are to be connected in their proper places in the circuit. This is the regular hook-up for a triple coil set.

that one complete turn has been wound, but that it zigzags from one side to the other and back, and instead of ending up where it started at 1, it goes past this point to 2.

This is the whole idea of the honeycomb winding; each turn starts a little beyond the preceding one and thus successive turns, while parallel, are spaced a fraction of an inch apart, reducing the distributed capacity effect. From 2, the wire passes to L, from there to 3, from 3, to M, and so on. When the winding comes back to 1, again it will be found that nineteen turns have been placed on the tube, and that they lie in a perfect lattice-work formation. For twenty-five turns the process is continued until 7, is reached; here a couple of turns are taken around this nail and, after leaving a few inches of free wire for making connections with the plug later on, the wire is cut. Except at the beginning and end it is not necessary to make a complete loop around each nail. It is better to simply run the wire around the outside of each nail, because this method of winding holds the turns secure.

When the winding has been completed cut a piece of the adhesive tape in half, lengthwise, so that one layer may be wound around the circumference of the coil to hold the wire in place while the nails are removed. Then with a pair of pliers pull each nail straight out in such a way that the wire will not be injured or pulled out of place. The tube is then slipped off the block and a layer of the one-inch adhesive tape placed over the previous layer of narrow tape. With this done the coil is completed. The other coils are wound in the same way.

It is well to remember, in winding larger coils, that each completed layer of winding consists of nineteen turns; therefore it is easy to keep track of the number of turns wound by multiplying the number of layers on nail 2, by nineteen. This will give the number of turns in the completed layers; the total may be found by adding the number of turns that have been wound on the top, but uncompleted, layer.

How to Prepare and Attach the Plugs

The plug consists of one of the fuses and a piece of the rectangular wooden block. Remove the fuse wire from the inside of the fuse by taking off one of the brass ends; cut out a piece of the fuse wire and replace the end. If burned out fuses of the proper size can be obtained so much the better, as it will then be unnecessary to remove the fuse wire.

Now prepare the wood block. Cut it up into one-inch lengths, one piece for each of the eight coils. Each of these blocks must have cut in it two grooves as shown in Figure 3. One is a rounded groove just large enough to allow the fuse to lie in it, and about ¼ inch deep; the other is also ¼ inch deep, but it is "V"-shaped and extends the entire width of the block. Shellac the block and when dried proceed to assemble the plug and mount on the coil. First put a drop of glue in the rounded groove and lay in the fuse in such a position that it will project an equal distance on each side. After the

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glue has "set" the plug is finished and ready to be mounted on the coil. Figure 3 shows the relative positions of the coil, block and fuse about to be assembled. They are fastened by winding adhesive tape through the coil and around the outside of the block and fuse. To complete the job one end of the coil winding is soldered to each brass end of the fuse. The end of the winding which runs back over the tube toward the fuse should be soldered to the top end of the fuse while the lower lead from the coil goes to the lower end of the fuse. It is important that the connections are made in this way; otherwise it will be found that when the coils are put into operation the windings of some are opposed to those of others.

How to Mount the Panel

The six fuse-clips are used for mounting. The positions on the panel are shown in Figure 1. An ordinary binding post is passed through the hole in the base of the clip and through the back of the panel, where it is secured with a nut. Contact is made to the other instruments by means of these binding posts on the back of the panel.

Figure 1 shows the front layout of the panel, Figure 4 shows the rear view with all connections. Plenty of space should be left clear at either side of the coil mountings; in tuning with honeycomb coils it is sometimes found necessary to have the primary and tickler coils swung around almost flat against the panel and there should be no obstructions to interfere.

In tuning with this outfit, coils suitable for the desired wavelengths are plugged in. It is difficult to give a table of the exact sizes to use for various wavelengths because the length of the antenna governs the sizes used for the primary coil, and the size of the tickler depends to a certain extent on the vacuum tube used. The chart printed below shows a table of the coils I use for the various types of stations that are within reach of the eight-coil set described. These are for use with an antenna of about 150 feet in length. The tickler sizes given are best for my set, but with different tubes larger or smaller sizes may be found best. This must be determined by experiment.

How to Tune

Until the adjustment of the set for the various wavelengths becomes familiar it is advisable to swing the primary and tickler fairly close to the secondary, say about one inch away. The primary condenser can be cut out entirely at first by throwing the series-parallel switch to the center position. Rotate the secondary condenser dial until the desired station is heard, until maximum volume of sound is obtained. Next move the tickler toward the secondary. If this process does not bring in the desired station it can be repeated with the primary condenser in series, or in parallel, depending upon whether the wavelength for which the set is being tuned is lower or higher than the normal wavelength of the primary coil used. I use the primary condenser only when tuning for amateurs on low wavelengths, when I throw the condenser in series with the antenna, or for very critical tuning, when I am trying to cut out nearby stations and to tune in distant ones.

Hard and fast rules for tuning cannot well be given; practice is necessary to give you such a knowledge of the set that will make tuning easy and enable you to cut out practically all interference.

THE WAVELENGTH CHART FOR THE HOME-MADE COILS

Class of Station	Approximate Wavelength	Primary Condenser	Primary	Secondary	Tickler
Amateur	200	Series	25	50	35
Broadcast	360	Cut out	25	50	35
Ship	600	Cut out	50	75	35
Navy Yard	1,800	Parallel	150	200	100
Arlington	2,700	Cut out	200	250	100

Radio Is Putting on Its Gum-shoes!

In the next number—out October 15th—the famous detective, William J. Burns, now officially known as chief of the Bureau of Investigation of the Department of Justice, will tell how radio is being used more and more in the detection of crime and in the pursuit of criminals, and will point out how the fans of the country may help the government officials in this work.

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TRANSMITTING IN NEW YORK—
Mr. John J. Carty—known to army men as Brigadier General Carty of the Signal Corps—chief engineer of the telephone company, talking into the microphone during the transatlantic tests.

"Hello, Europe!"

How Single Side-band Radio Telephone Transmission is Bein Developed for Talking Across the Ocean

This article tells how the experimental suppressed-carrier system works to increase the efficiency of transmission, how it cuts out useless wastage of electrical energy, how it takes up less wave-space in the ether, and how it puts all of the power where it can be used—in the modulated portion of the wave.

By HARRY A. MOUNT

THE first transmission of the human voice across the Atlantic was accomplished by means of radio in 1915. Using the navy's antenna at Arlington, Virginia, with a special transmitter, the telephone engineers stationed at the Eiffel Tower, Paris, were able to hear disconnected words and parts of sentences.

Last January the experiment was repeated, this time using the antenna of the Radio Corporation of America at Rocky Point, L. I. This time a group of prominent men and scientists in London listened for two hours to speeches made into an ordinary desk telephone by officials of the American Telephone and Telegraph Company in New York.

The guests in London heard what was said with as much clarity as over an

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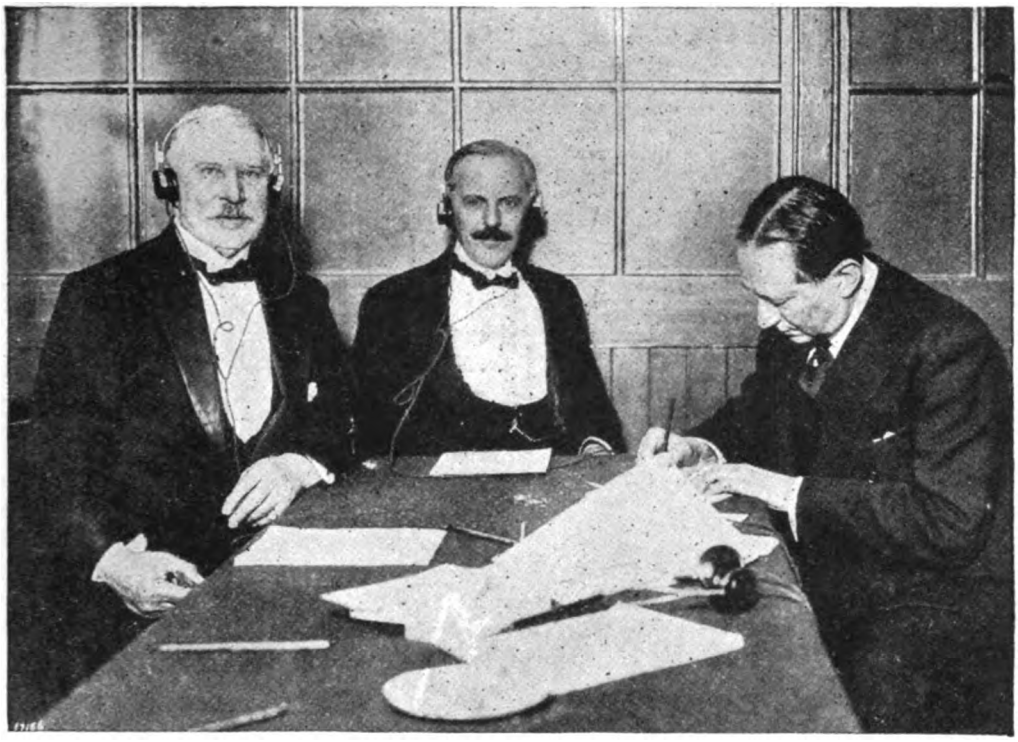

—AND RECEIVING IN LONDON

Those who participated in the tests overseas are (left to right) Sir Evelyn Murray, Secretary of the British Post Office, Sir A. Sherley Benn, M. P., and Guglielmo Marconi.

ordinary telephone line. During a part of the time a loudspeaker was used, and reporters easily made transcriptions of what was said. This was made possible by a new system of radio telephony, here employed for the first time. It is known as the suppressed-carrier, single side-band transmission scheme and represents in many respects a great advance in radio telephony over the ordinary methods of transmission and reception.

Tests which have been carried on almost continuously between New York and London since January have served to confirm the results first obtained. As compared with the ordinary system, the new method has the following advantages:

1. The increase in the effectiveness of transmission is because all of the energy radiated is used to carry the message, whereas by the ordinary method probably only about one-third of the radiated energy is effective:

2. The stability of transmission is improved:

3. The frequency band required for transmission is reduced, thus conserving wavelength space in the ether.

4. The system makes use of new water-cooled vacuum tubes, by means of which the power of the transmitted currents is amplified to the order of 100 kilowatts or more:

5. A highly selective and stable type of receiving circuit is employed, by means of which static and other interference is reduced to a minimum.

It is well known that when a carrier wave is modulated by a voice current, the power given out is distributed over a small frequency range, and may be considered in three parts: (1) energy

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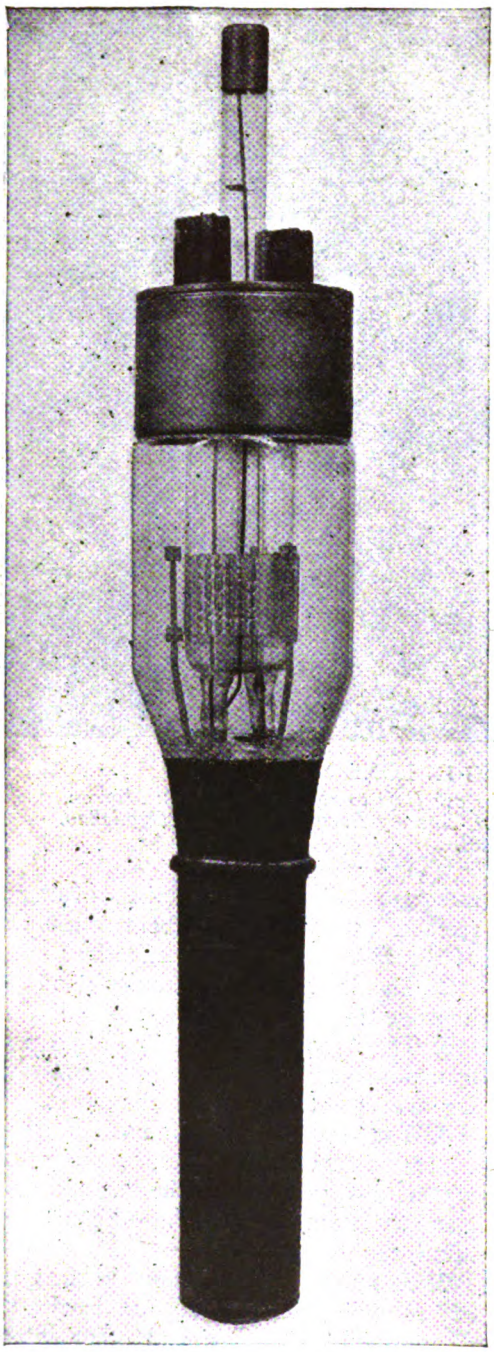

THE BASIS OF THE
TRANSATLANTIC SYSTEM

One of the large high-powered water-cooled tubes that are used in the new system. It is capable of delivering ten kilowatts of electrical energy.

at the carrier frequency; (2) energy distributed in a frequency band extending from the carrier upward, and having a width equal to the frequencies appearing in the telephone wave, and (3) energy in a band extending from the carrier downward and having a similar width.

Ordinarily about two-thirds of the total power is in the unmodulated part of the carrier wave, which, in itself, carries no message, and the remaining one-third of the power is distributed equally between the two side bands. In this system a method is employed for suppressing the unused part of the carrier wave so that it is not sent from the antenna, and so that all of the active power is concentrated in that portion of the wave which carries the message. Furthermore, it is only necessary to transmit one side band, the other is suppressed with the unmodulated carrier.

The sending of a single side band makes necessary the use of a very special type of receiver—but before we consider this, let us see just how the suppression of the carrier and one side band is accomplished.

Figure 1 is a diagram of the transmitting circuit. The circuits drawn in light lines represent those stages of the process carried out at low power, while the high-power rectifier and amplifiers are indicated in heavy black lines.

Beginning with the voice input on the lower left corner of the diagram, we at once notice two devices, unusual in radio practice. These are the balanced modulator and the band filter. The balanced modulator is the device which eliminates the carrier. It consists of two vacuum tubes connected back to back in a balanced system, as shown, whereby the carrier frequencies in the output of the two tubes balance and cancel each other, while the modulated portion of the wave is not affected and is passed through the split transformer to the band filter.

This electrical wave filter is one of

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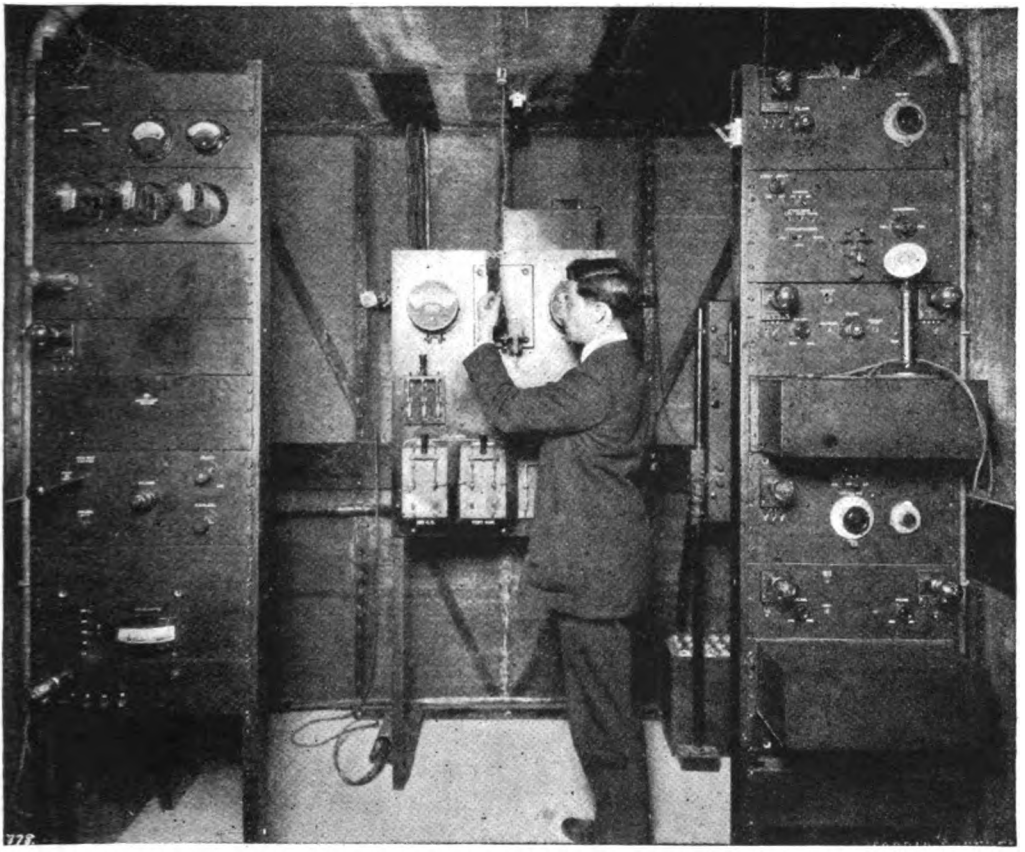

Western Electric

The low-powered control board which consists of the electric-wave filter circuits, the balanced modulators, and the smaller power amplifiers.

the most important developments of the telephone laboratories. It is a combination of inductances and capacities which allows a predetermined band of waves to pass, but turns back all other frequencies. The filter functions best at the audio and lower radio frequencies, and in this range it is much better adapted to the sorting and separating of various frequencies than the tuned circuit.

In this case the frequencies selected for transmission (55,800 to 58,500) are above the range for close selection by the filter, and so modulation and selection are carried out in two stages. The purpose of the first is to widely separate the side bands, so that selection will be easier.

In the first balanced modulator a carrier frequency of 33,000 cycles is employed. In the output circuit of this modulator there are present only the two side bands, one ranging from 33,300 to 36,000 cycles, and the other extending from 32,700 down to 30,000 cycles, the speech frequencies being taken as a band extending from 300 to 3,000 cycles. In this case the filter is designed to pass *only* the lower side band and to suppress the upper side band. This lower side band is then used in the second modulator to modulate a carrier wave with a frequency of 58,500 cycles a second. As in the previous stage, the carrier is suppressed in the balanced modulator, and in the output of this modulator appear two side bands

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widely separated in frequency. The upper side band represents the sum of the two input frequencies, and extends from 118,500 to 121,200 cycles, while the lower side band represents the difference of the two frequencies and extends from 58,500 down to 55,800 cycles. Again the lower side band is selected by the filter and the upper band is suppressed.

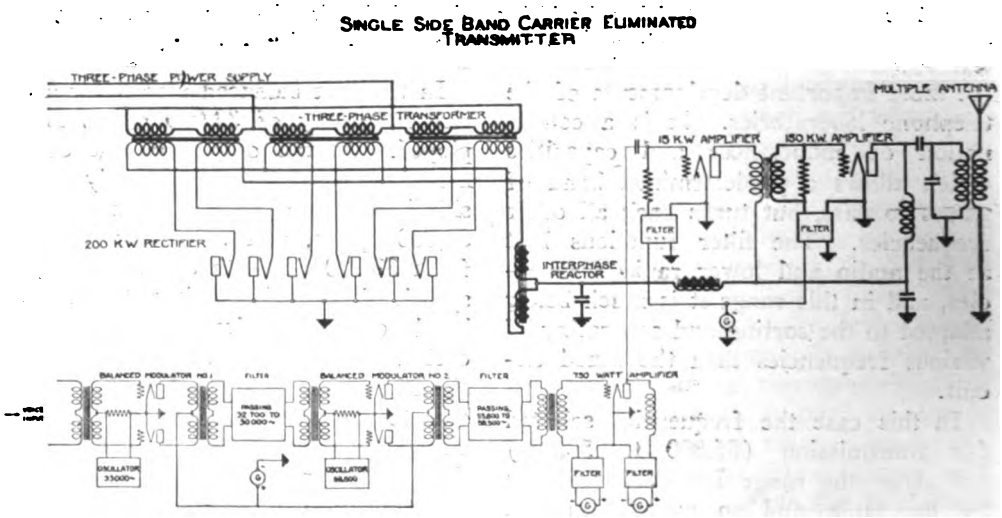
Having thus prepared *at low power* a high-frequency current embodying the original voice current, but representing only a single side band and without any unmodulated carrier current, it is then put through a series of amplifier tubes before reaching the transmitting antenna. The amplification is carried out in three steps.

The first stage employs three glass vacuum tubes rated at 250 watts each and operated at 1,500 volts plate potential. These increase the power to about 750 watts. The output of the 750-watt amplifier is applied to the input of the high-power amplifying system, beginning with the 15-K.W. amplifier of Figure 1. This consists of two water-cooled tubes, rated at 10 K.W. each, operating in parallel, at approximately 10,000 volts.

The high-voltage D.C. supply is furnished by a large vacuum-tube rectifier unit, consisting of twelve water-cooled two-element tubes, rated at 200 K.W. It utilizes a 60-cycle, 3-phase current and rectifies both halves of each wave, the two halves being combined by means of an inter-phase reactor, which with the retardation coil and condensers shown, smooth the ripples out of the current.

The final super-amplifier consists of two units of ten water-cooled tubes each with a total capacity of 150 K.W. The enormous power of this transmitter may be realized from the fact that most of the "large" radio broadcasting stations use a power of about ½ K.W.

In this scheme for reception a continuous oscillatory current of the correct frequency has to be supplied in the receiving set before detection of the signal is possible. Thus a small vacuum-tube oscillator is used to feed into the receiving circuit a small current with a frequency of the original carrier current, 58,500 cycles. This, when de-



THE TRANSMITTING SYSTEM

FIGURE 1: *This is a schematic drawing that shows the complete transmitting system; it shows the general connections for the modulators, the heterodynes, the filters and the low and high-powered radio-frequency amplifiers.*

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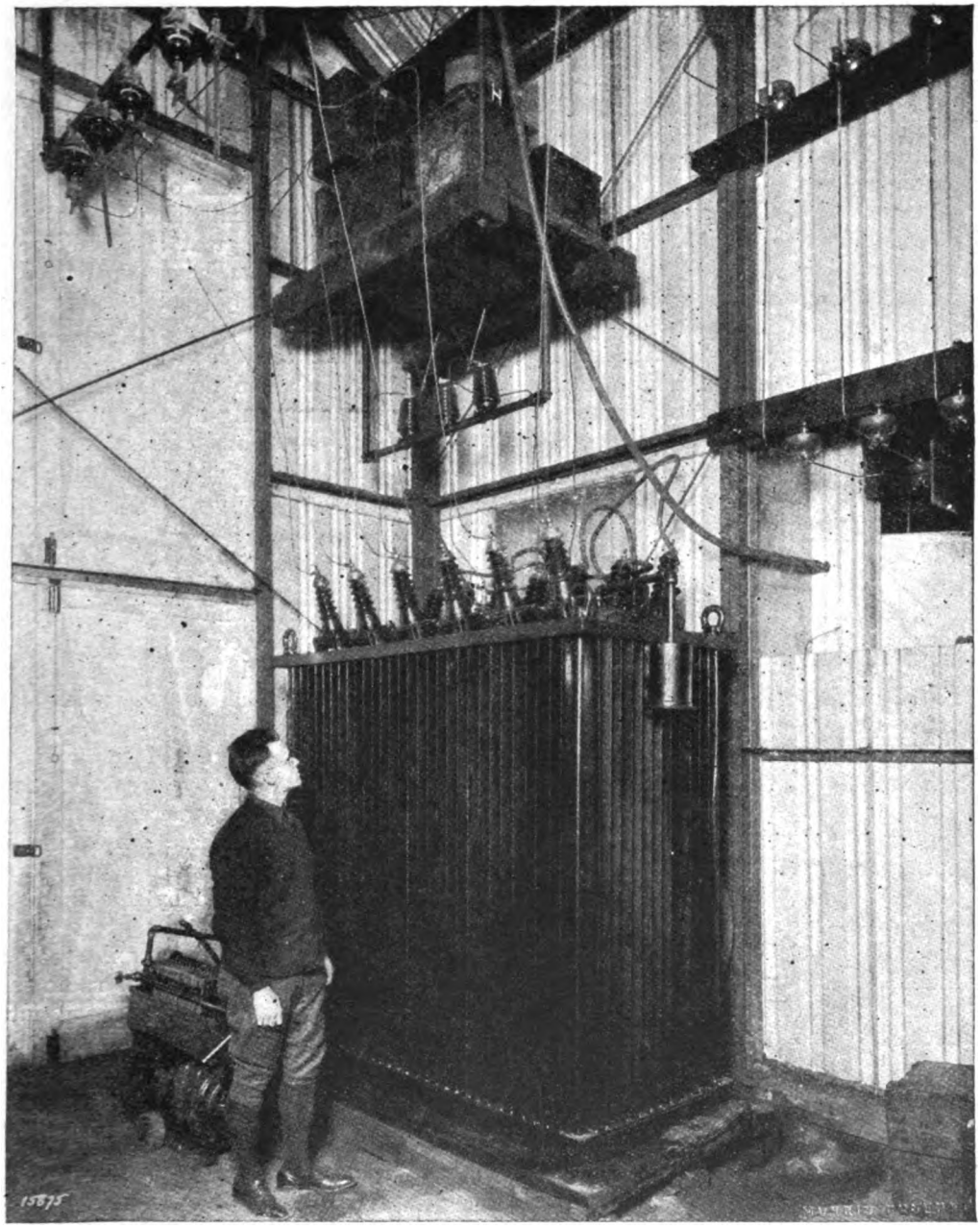

Western Electric

SOME OF THE ENORMOUS APPARATUS USED IN THE TESTS

The giant 60-cycle, 3-phase, oil-cooled power transformer which supplies the 200-kilowatt rectifying tubes with high-potential alternating current. The tubes change this current to direct current and pass it on to the plate circuits of the radio-frequency amplifiers.

modulated with the received side band, which has a frequency of from 55,800 to 58,500 cycles, a difference in frequency of 300 to 3,000 cycles (that is the voice frequency) will result. A variation of about 50 cycles either way, in the sup-

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plied carrier frequency is allowable, but a greater difference will produce distortion of the speech. There has proved to be no difficulty, however, in keeping within this limit.

Actually, the procedure is not quite as simple as this. Use of the intermediate wave amplifier and the band filter is made at the receiver also, and, in order that the filter may function effectively, the received side band is also stepped down in frequency. This stepping down action is accomplished by combining in the first detector, the incoming band with a locally generated current of 90,000 cycles. Two different frequency bands are produced, the lower of which is from 34,200 to 31,500 cycles. This is selected by a band filter, which provides an extremely sharp discrimination against all other frequencies. Another local oscillator supplies to the second detector a current of 34,500 cycles, and the difference in frequency in the output of this tube is the original voice wave. This current is passed through the audio-frequency amplifiers and to the receivers. (A schematic diagram of the receiver is shown in Figure 2.) Variations in tuning, without changing the values of the band filter, are possible in this receiver, merely by changing slightly the frequency of the 90,000-cycle current supplied to the first detector, so that the receiver is at once a flexible and a highly selective device.

This elaborate arrangement is not necessary, however, to receive a single side-band radio wave. The well-known heterodyne circuit will receive it and sometimes the ordinary regenerative circuit can be made to serve, although in either case adjustment of the local oscillations is somewhat difficult.

In view of the great advantages inherent in the system, however, it is considered not unlikely that broadcasting may some day be done on this scheme. In this case, each receiving set would have in addition to the tubes now employed, an oscillating tube to supply the continuous oscillatory current.

Such a system would have many advantages, some of which are the following: When only one side band is transmitted, nearly twice as many broadcasting stations could operate simultaneously without interference in the ether. Also the effectiveness of the power used would be increased about three-fold. Furthermore, since the strength of the received signals is proportional to the energy of the carrier, the receiving of very weak signals could be more readily accomplished in the present system where the carrier is supplied locally and its energy can, therefore, be controlled by the operator of the receiving set.

This system opens up an interesting field of possibilities, in which radio listeners may suddenly find a very intimate interest.

THE RECEIVING SYSTEM

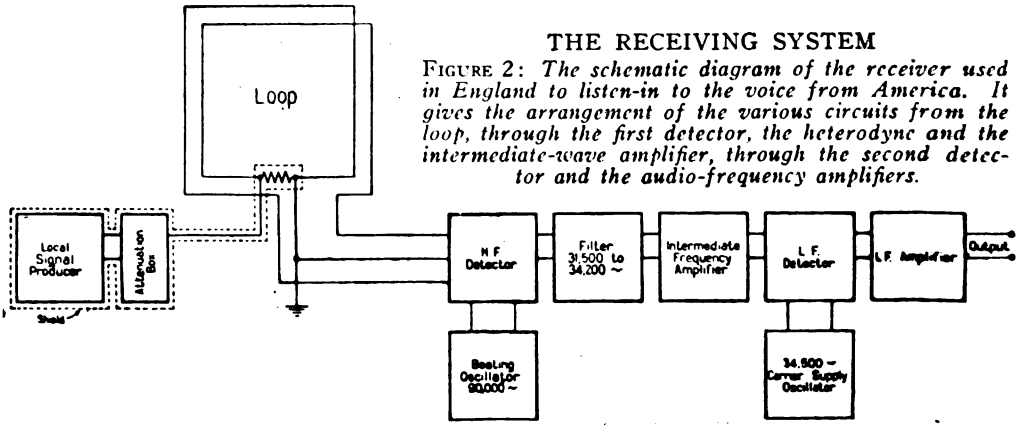

FIGURE 2: *The schematic diagram of the receiver used in England to listen-in to the voice from America. It gives the arrangement of the various circuits from the loop, through the first detector, the heterodyne and the intermediate-wave amplifier, through the second detector and the audio-frequency amplifiers.*

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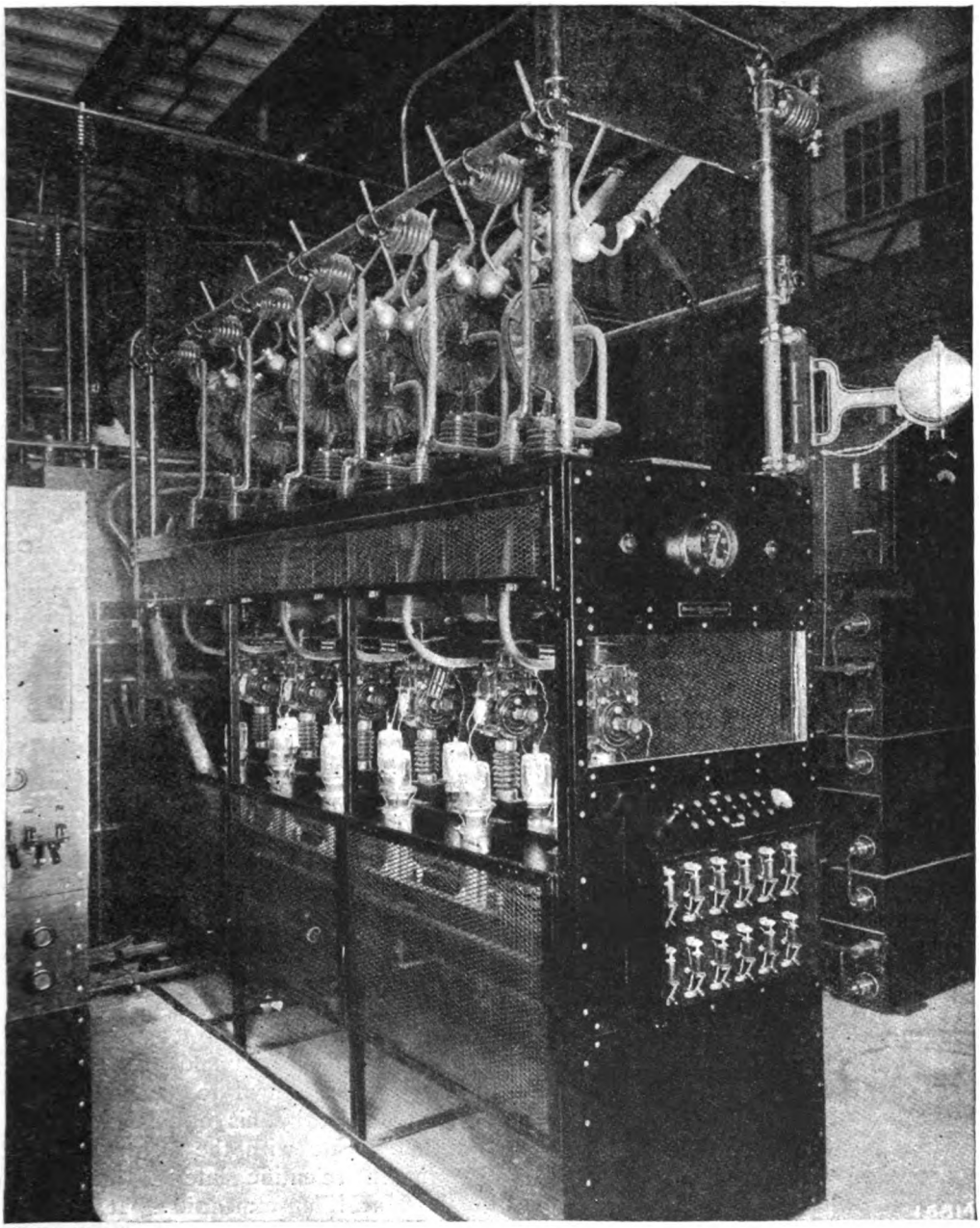

Western Electric

THE RECTIFYING APPARATUS
SET UP IN ITS PROTECTING FRAME

Here are included the high-tension bus, the insulators and choke coils in the upper compartment, with the rectifier tubes and circuit breakers in the lower screened compartment. The plates of these large tubes are made of metal and form part of the wall of the tube. They are set into a water-cooling system which carries away the great heat which is set up by the electron stream within the tube.

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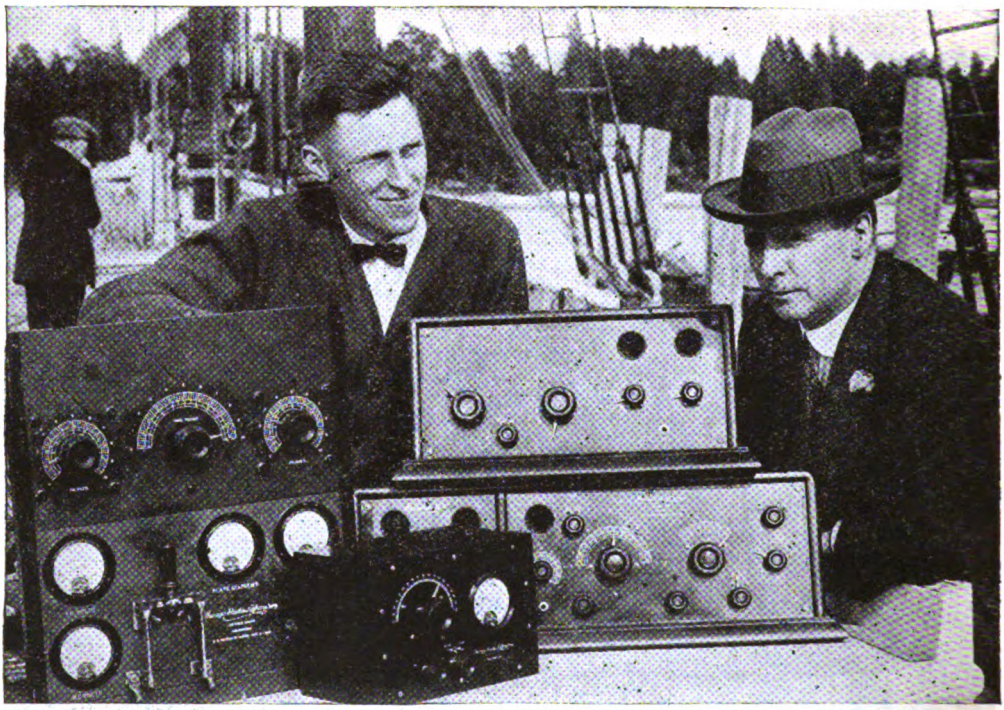

North American Newspaper Alliance.

THE RADIO VOICE AND EARS OF THE EXPEDITION

At the left is shown the modern C.W. transmitter, which can be tuned to an exact amateur or broadcasting wavelength by means of the wavemeter shown in front. At the right the long wave receiver (above) and the short wave receiver (below) will insure reception from all classes of stations. The operator, Donald Mix, is shown at the left, and Capt. Donald B. MacMillan at the right.

Radio's Farthest North

The adventuresome voyage of a radio amateur on the polar ship BOWDOIN, and what it may mean to science

By ROBERT W. HARWOOD

"WNP," for the next fifteen months or perhaps longer, will signify the call of Dr. Donald B. MacMillan's latest polar expedition. The call letters are unforgettable for they mean "Wireless North Pole." Unless the most careful plans miscarry, they should play an important part in the history of radio.

Setting sail on the tiny auxiliary schooner *Bowdoin* the MacMillan expedition is to permit itself to be locked in the ice during the long winter nights. And each night Donald Mix, an operator who is known to "hams" all over the country by his old call, 1TS, will communicate with the amateurs.

Much scientific interest attaches to the MacMillan expedition. It is a two-phase interest—radio and the study of glacial action. It would be difficult to say which is of the most importance.

MacMillan first went to the Arctic with Peary in 1909, the trip that won discovery of the North Pole, and since then he has spent four years in the Arc-

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tic in pursuit of scientific data. His studies of the glaciers has led to a theory, entertained by himself as well as other scientists, that a new Ice Age is approaching. In support of his theory he has found signs of increased glacial activity, or rather the greater activity he discovered among the glaciers, led to the theory. He now intends to make an accurate survey of certain of the great glaciers, and the great ice cap over Greenland to learn if it has advanced.

Scientists know little of the causes of the irregular return of the Ice Ages, the last of which retreated from New England and other parts of the United States about 30,000 years ago, and from Northern Europe more recently. Any search for the causes has, therefore, a paramount interest in scientific circles. Scientists want to know if there is any indication that Manhattan Island, for instance, will once more be covered with a mighty glacier, higher than the Woolworth tower.

It is in radio equipment, however, that the MacMillan expedition makes a departure which marks history for exploration of the north. Never before have plans been made to keep closely in touch with the outer world. Explorers have spent long years in the north with nothing heard from them until they returned. Many of them have perished miserably for the lack of radio communication.

The aurora borealis, weird electrical phenomena of the Arctic, has been known to interfere with radio and with telegraph lines as well; it has, in effect, erected a great static wall in the air.

International.

THIS MAY PROVE TO BE ONE OF THE HISTORIC RECEIVING SETS

If the plans carry, this apparatus installed in the radio shack of the BOWDOIN *will not only reach the farthest north of any similar equipment but will be the means of acquiring scientific information of real value to radio everywhere.*

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But Mix and his chief, MacMillan, and other experts who have installed the radio equipment on the *Bowdoin,* are not afraid of the aurora borealis. In the first place they plan to be far north of the latitude in which it exists. And there is no comparison between the crystal detector and tuning coil of former days with the sensitive apparatus on the *Bowdoin.* In the early days of radio equipment it would have been impossible to have kept in touch with the outer world, but now MacMillan plans to have a careful study made of the aurora borealis by means of radio.

Radio communication plans for the expedition were worked out by officials of the American Radio Relay League and the *Bowdoin* is to communicate with members of that organization of amateurs. At certain hours each night Mix listens-in and all calls he receives are logged and sent back for study. Each week MacMillan sends out a story of the expedition and its findings to some one of the amateurs. The amateurs hand over the story to the press.

Mix tunes down at times and at other times he broadcasts so that there is ample opportunity for most of the 25,000 amateurs in the country to hear him at one time or another.

Many obstacles to radio communication with the Arctic are presenting themselves, but the radio engineers who have worked on the *Bowdoin* believe these have been overcome. All of the equipment was tested and retested for cold and other Arctic conditions before the vessel sailed.

The *Bowdoin* is small and shallow and every inch of space on her counted. She is a schooner and there was difficulty in rigging her antenna and the lead-in wire. Proper insulation of the lead-in wire alone was a difficult problem for the boat will often be in a temperature of 70 degrees below zero while the inside of the cabin will be 70 degrees above, and the slightest metallic connection with the exterior and interior under such conditions makes it almost impossible to prevent forming of ice on the inner end of the conductor.

The over-all length of the *Bowdoin* is 89 feet. She is purposely small in order that she may easily arise when the ice floes close in. While powerful ships are apt to be crushed, a shallow, light craft will be lifted out of the water. Not since the days of the vikings have explorers braved the Arctic in so small a boat.

As to her success in the Arctic the world is to learn more—by radio.

How to Select Your Radio Parts

THE efficiency of your set is largely dependent upon the efficiency of the various units of which it is made up. Do you know how to pick out a good variometer? Can you tell a well-made from a poorly-made condenser? Do you know how to test a pair of headphones? In the following issue—the big November number—an expert will give you practical pointers for selecting your apparatus.

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Impressive Tribute Paid by Radio to the Late President

THE important part that is played in our daily life by radio was forcibly impressed upon the public when, following the death of President Harding, a majority of the broadcasting stations throughout the country closed down for varying periods as a mark of respect. From Washington, D. C., comes the following comment:

The almost complete cessation of broadcasting brought home as could nothing else the important niche which radio has carved out for itself in our daily routine in the past two years. People in all walks of life commented upon the gap in their evenings, a gap which they found hard to fill, and while practically all agreed that it was but fitting that the broadcasting of entertainment should temporarily halt while the country sorrowed, probably nothing else connected with the final honoring of our dead President made as deep an impression.

In the death of President Harding, radio lost a good friend. He was one of the first officials of the Government to turn radio fan when, following the first radio conference in 1922, the attention of the country was turned toward the new method of entertainment. The set built for his use in the White House was the last word in reception, but, while he liked to "play" with it, he had but little time to devote to amusement and found himself for a long time unable to cope with the interference which prevailed when there was but one wavelength for broadcasting.

In many ways the President evinced his interest in radio. He gladly accepted the invitation extended to him by the National Press Club of Washington to attend the exercises incident to the "christening" of its receiving set, and while the music and speeches which were to have been broadcast from a near-by Government station especially for the occasion failed to "come through" the President "stuck around" like the "good fellow" he always was, chatted with the members of the club—which is composed of newspaper men—and gave them a little talk on the difficulties of being President which gave them much inside dope on the great task which confronts the Nation's Executive from day to day.

While the failure of Congress to pass the White Radio Bill kept radio from becoming an official subject of consideration at the White House, Mr. Harding frequently expressed his interest in the matter and the hope that legislation could be enacted to eliminate interference, give the amateurs the privileges they desired and which he thought they were entitled to, and put radio on a concrete foundation. President Harding was radio's friend, and no finer tribute could have been paid than the silencing of more than five hundred stations, while the country ceased its activities and a hundred million people mourned.

—CARL H. BUTMAN

A Chance for the Radio Dramatist

RADIO broadcasting station WGY at Schenectady, N. Y., is offering a prize of $500 for the best "radio drama" submitted in competition during the three months period beginning September 1. The prize-winning play will be presented during the winter months when transmission conditions are best. Other plays offered in competition will be produced *via* the ether, if they are found suitable, and the authors will be remunerated.

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THE DETECTOR IN USE

The last step in construction is to solder the crystal in place by means of "Wood's" metal. Adjustment is then made with the pointed brass rod.

Silicon and Carborundum as Crystal Detectors

IF you do not want to use a bulb, and if you find that galena gets out of adjustment too easily, here is a suggestion from a New Jersey amateur that will help you out. The pressure-contact detector here described has these inestimable advantages—it can be easily and cheaply made, and it will "stay put":

To the majority of broadcast listeners the names of "silicon" and "carborundum" are little known. The knowledge of crystals of the ordinary novice extends to galena and to one or two crystals that are sold under trade names. A little experimenting with the two first-named crystals will, however, reveal possibilities and furnish an interesting line of study with gratifying results.

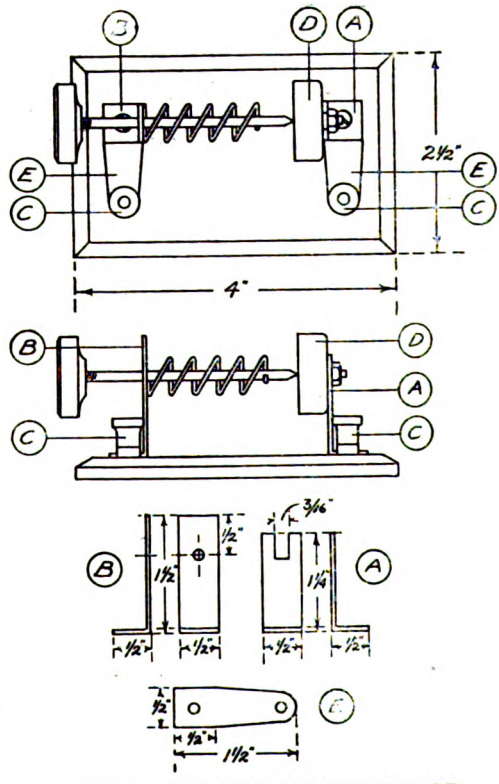
These two crystals are not natural minerals; they are products of the electric furnace. They both possess the properties of rectification to a more or less marked degree and they have several points of value in radio reception not found in other crystals or minerals. Stability of adjustment is one of the greatest of these; long life is another. Because of the heavy contact used, the film left on the surface of the crystals when they are handled does not affect the operation of them as it affects other crystal rectifiers. Dust and weather conditions (important factors in the use of light-contact detectors), are practicaly negligible with either carborundum or silicon.

Up to a few years ago carborundum was used almost universally on board ship where all kinds of conditions were met with; there it gave good service. Now, however, the audion has superseded the crystal except on board small coastal and harbor vessels.

The accompanying diagrams show the details of an easily constructed yet efficient detector-stand in which either carborundum or silicon may be used. The base, made of any good insulating material, is 4 inches long by 2½ inches wide, with neatly beveled edges. The component parts of the detector may be mounted directly on either a horizontal or vertical panel; in the later case, the cup support should be the lower one.

The two standards are made of a 1/16-inch brass strip ½ inch wide. Two strips are required, one 2 inches long and the other 1¾ inches long. A ¼-inch hole is drilled in the longer one, the center of the hole being ½ inch from the end. The other end is bent at right angles at a point ½ inch from the end. In one end of the second strip a slot is cut. The other end of this strip is bent as in the first strip.

A stiff spiral phosphor-bronze spring, ¼ inch in diameter and 1½ inches long when at



HOW TO MAKE THE DETECTOR

A and B show the standards; C shows the binding posts; D shows the detector cup; and E shows the metal connecting strips.

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rest, is next obtained. One end of this is soldered to the upright with the hole in it as shown. A 3-inch piece of ⅛-inch brass rod is now threaded for ¼ inch on one end and filed to a point on the other. A suitable insulation now is screwed on the threads, and the pointed end passed through the hole and the spring as shown. The free end of the spring is soldered to the rod, ¼ inch from the point. The standards are now mounted and connected to the binding posts.

Mounted crystals may easily be slipped into the supporting standard by the slot that has been made. It will be necessary for the amateur to mount his own crystals in cups with mounting screws. The cups may be obtained from the tops of the carbons in old dry cells and the crystals held in them by means of "Wood's" metal.

This stand, when used with silicon, should be connected in the circuit in the regular way, but with carborundum it is sometimes found advantageous to employ a dry cell or two in conjunction with a potentiometer.

In selecting crystals care should be taken to use only fused silicon and carborundum made specially for radio reception. Because of their ruggedness and the ease with which they may be adjusted, these crystals will be practicable for use in crystal sets.

While this type of crystal, which utilizes the pressure contact, may be slightly less sensitive than the more critical kind, it will be found to be much more stable and better able to stand up under the "knockout" blows of heavy static.

—Le Roy Western

Transmitting and Receiving on a Loop

WE have heard much in the last few years of reception of radio signals on a loop antenna; in fact, it has become common practice. Here is a new development that permits of both transmission and reception on a loop.

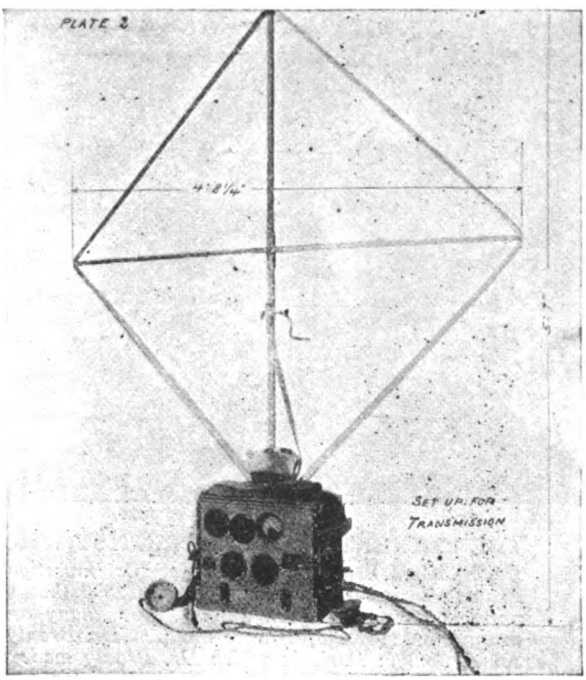
The set developed by the Signal Corps (SCR-112) consists of a combination send-receive unit with a portable, collapsible loop that is capable of two-way communication by CW. with a range of three to five miles. When the set is connected up for operation (as shown in the illustration) it takes up only as much space as an average man with his arms extended. The set was designed for army use and should prove of great practical value in maneuvers where directional work of short range is of the utmost importance. The unit has a wavelength range of 110 to 140 meters for transmitting and from 85 to 165 meters for receiving.

It will interest the amateur to know that such a set has been made and that it works, and amateur experimentation along this line would assuredly lead to the development of a set for short range work that would undoubtedly cut down local interference to a minimum.

—Frederick Siemens

A CW. Transmitter That Employs a Loop

This apparatus should be of more than passing interest to the amateur, especially if the amateur is located in a congested locality, for it offers a solution to the problem of local QRM (interference). By the use of such a set, two amateurs could send and receive messages without causing QRM to other amateurs in their vicinity; this is because the loop transmitter is exceedingly directive.



S. R. Winters

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First Aid to Seamen by Radio

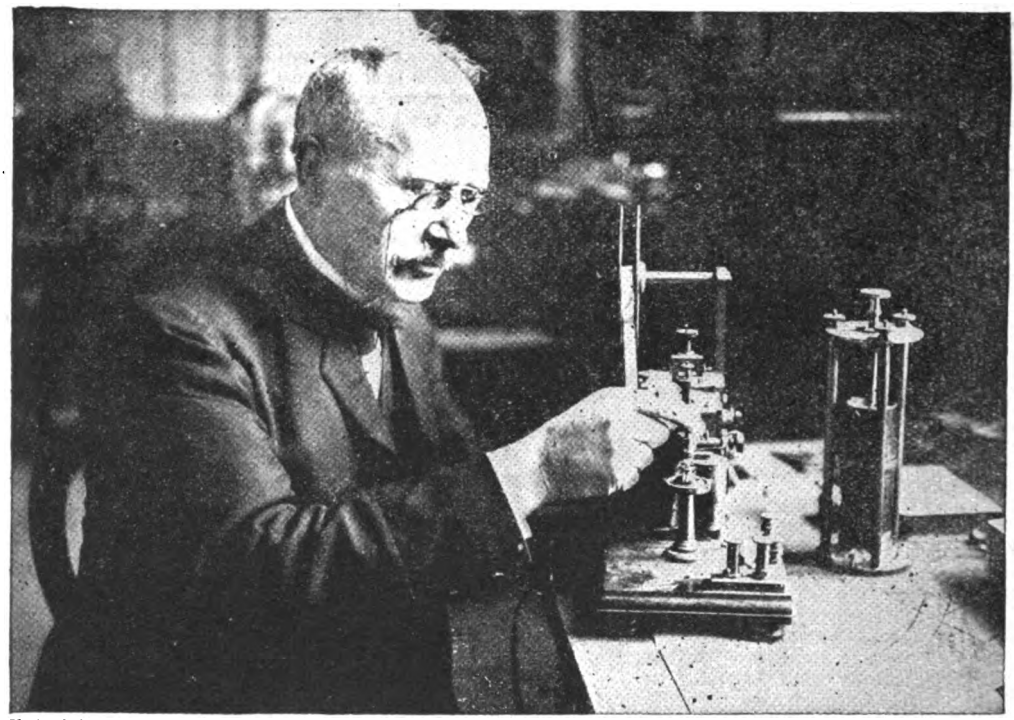
THE saving of life at sea by carrying medical advice to ships which are not provided with a doctor is now a recognized service of radio. How this service is being provided by the U. S. Government is described as follows in a bulletin from the Department of Commerce:

The probability that some masters of seagoing vessels may not as yet have been fully informed in regard to the right of members of their crews to medical service by radio while at sea and to treatment in hospitals of the U. S. Public Health Service on reaching port has caused Surgeon General H. S. Cumming to direct the preparation and sending of posters giving full information to all vessels of the American Merchant Marine.

Curiously enough, the medical service afforded by our department is really a sort of subsidy to merchant ships and sailors. A century and a quarter ago, when Congress established the Public Health Service under the title of the Marine Hospital Service, it directed it to render medical aid to every American seaman who applied for it. For this service each seaman was required to pay twenty cents a month. This was in 1798; in 1870 the tax was doubled; but in 1888 it was abolished. Since then all such aid has been rendered free. Even the expense of calling the Service by radio from ships at sea is borne by the radio companies without expense to either ship or sailor.

The U. S. Public Health Service provides hospital care and out-patient treatment for sick and disabled seamen. Hospitals with modern equipment, skilled physicians, specialists, dentists and trained nurses are open to all persons employed on documented American vessels, and to the coast guard, lighthouse keepers, and to all others who help to keep the flag on the seas.

An ambulance will go to the dock at any time upon telephonic request from a ship's officer, and any Marine Hospital will prescribe emergency treatment through radio shore stations.



Kadel & Herbert

THE EMINENT FRENCH SCIENTIST WHO INVENTED THE COHERER

Dr. Edouard Branly, one of the earliest investigators of radio waves. It was Dr. Branly's invention of the coherer in 1890 that made possible the first success of wireless telegraphy. On June 7, 1923, many of the most distinguished scientists and radio experts of France honored Dr. Branly by a jubilee meeting held in the same room in Paris in which Dr. Branly made the address announcing his great discovery nearly thirty years ago.

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International

OPEN-AIR RADIO CONCERTS IN ENGLAND

This picturesque canvas-covered cottage, built on a Ford chassis, has recently been touring about John Bull's little island and entertaining groups of villagers with entertainment picked up from the broadcasting stations. The loudspeaker may be seen through the window. A short antenna is mounted on the roof.

Back to the Farm for a Loudspeaker

THE radio fan who cannot invest in an expensive loudspeaker will welcome this practical hint as to how to make one at home; it comes to us from a reader who spent his boyhood upon a farm:

Here is a loudspeaker which can be made at home for about $7.00; the only materials you need to obtain are a loudspeaking unit (such as the Baldwin type C, for example), a brass rod, some string, washers, screws, and an ordinary gourd.

Cut a slice off one side of the gourd as if for a dipper; then remove the seeds. Do not scrape out the seed tissues, however; let them dry to the walls of the gourd. When the gourd is thoroughly dried out, the shell with these tissues will be hard. You may then stain, varnish and finish it to suit your own special taste.

When the gourd has been thus prepared, drill a ⅛-inch hole through each side of the handle about one inch from the end; insert a ⅛-inch brass rod through these holes to act as an anchor rod.

Take two silk fishing lines, cut them to a length a little greater than the length of the gourd and resin them thoroughly. Drop these lines into the opening in the handle of the gourd and tie them to the brass rod at points about ⅛-inch to ¼-inch apart.

Next make a small round brass concave washer of a size to fit over the center of the head of the gourd. Drill two holes about ¼-inch apart in the washer and insert two 1½-inch screws in these holes. (See that the screws have nuts screwed back to the shoulder or head.) Drill a small hole in the threaded end of each screw which is large enough for the ends of the lines to be put through it and tied. Tie the lines, then grip each nut in turn with a pair of pliers, and back out the screws with a screwdriver until both the lines become taut.

Saw off the small end of the handle of the gourd and fasten the loudspeaking receiver unit in place in any suitable manner. You are then ready to tune in with a loudspeaker that will give excellent results.

—W. H. RUNYAN

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THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask the* SERVICE BUREAU.

THE flood of inquiries that has poured in upon the Service Bureau has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

¶ *In justice to our regular subscribers, the Service Bureau is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry. No inquiries can be answered personally or by telephone.*

QUESTION: How many tubes are necessary to receive from broadcasting stations located in the same town with enough volume to operate a loudspeaker in a small room?

EDWIN MORRIS

ANSWER: Two tubes. One, a detector tube in a regenerative circuit, and the other, used for an audio-frequency amplifier, will give you the requisite amount of volume for your purpose.

* * *

QUESTION: What is the longest antenna length that can be used successfully for listening to broadcasting with a standard make of receiving set?

WILL ATKINSON

ANSWER: The two limits are 75 to 200 feet. The best length to use will be around 150 feet. If you use a short antenna it would be better to use a variable condenser shunted across the primary coil of the set, and if you have a long antenna, a variable condenser connected in series with the primary coil will help.

QUESTION: I have found that I can tune my single-circuit receiver by inserting a large iron nail inside of the primary coil. If I push it in all the way I increase the wavelength and receive the higher stations, and if I insert it only a little way I get the lower stations. Why is this? Have I discovered something new?

O. F. JOHNSTONE

ANSWER: No, you have discovered nothing new. This is one of the elementary principles of induction. If you use a coil with an air core, the coil will have a certain value of inductance. If, however, you wind the same coil, with the same dimensions, on an iron core, you will find that the inductance has increased enormously. That is what you are doing with the nail, and when you use a larger inductance you raise the wavelength. This kind of tuning is not as efficient as the ordinary tuning by means of variable condensers or variable coils, as the nail introduces losses (somewhat similar to resistance) into the coils at a radio frequency.

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QUESTION: I have a single-circuit set that employs two honeycomb coils in a double-coil mounting used in connection with one variable condenser and a vacuum tube, type WD-12. I have heard a number of long-distance stations with this set, but the tuning is not good. I have to sit up very late in order to get any distance at all, and then the distant stations seem to interfere with each other a lot.

Is there any way I could turn my present set into a four-circuit tuner? If this is possible, I would like to get the circuit.

A. VICKERS

ANSWER: It is not possible to convert the single-circuit set into the four-circuit, without obtaining almost a complete new set of parts. You may, however, use the principle of the stabilizer coil with your present set, by changing from the two-coil mounting to a triple-coil mounting, and using the third coil, L1, an L-35 honeycomb coil shunted with a .0005 mfd. variable condenser, to control regeneration to a finer degree. This will improve your present set considerably. The circuit is shown complete in Figure 1. Tune with condenser, VC2, almost "all in."

QUESTION: What is the proper way to check up on "B" batteries to tell when they are run down? Is it all right to use a 110-volt lamp to connect across them in order to see whether or not they have any juice left in them? A friend of mine told me that this was bad for the batteries. Is this so?

FRANK J. FINCH

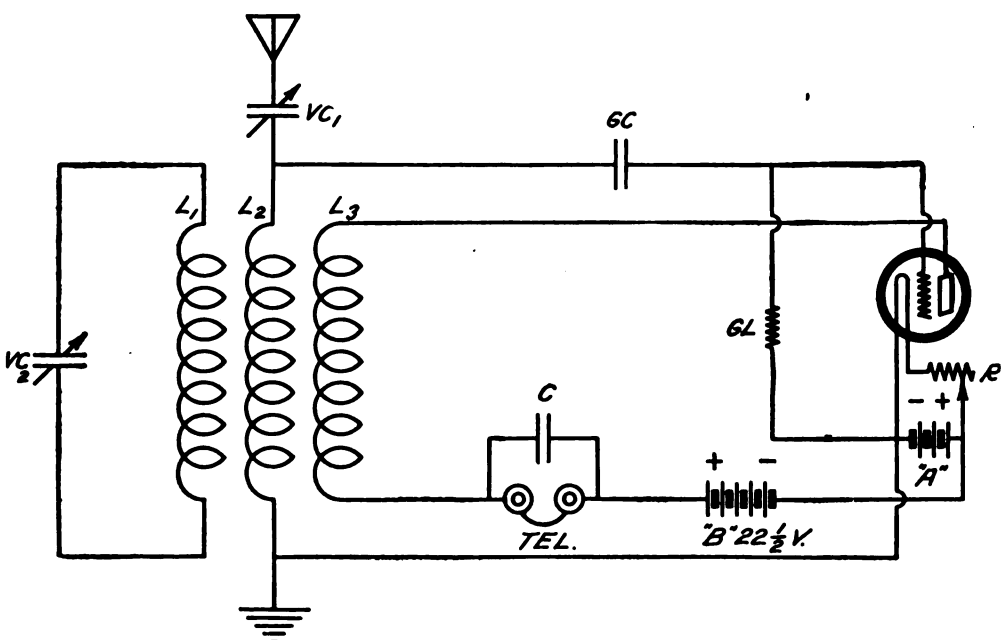
ANSWER: The method you describe is not good for the batteries. If you do this you probably run the batteries down more in a second than you would by a month of steady usage on the receiving set.

The proper way is to obtain a small battery voltmeter, which can be obtained for three or four dollars, that will tell you at a glance just what is the voltage of each battery in the circuit. By this method you can pick out instantly any battery that is low or defective. At the same time you will be sure that you are not spoiling the batteries while testing them.

* * *

QUESTION: I can receive with my regenerative set from local stations without any "B" batteries. The signals are not as loud as when the batteries are used, but they come in comfortably well. I have a single-tube set and all

FIGURE 1: *A stabilizer circuit VC1 and L2, added to a single-tube regenerative circuit to aid in tuning.*



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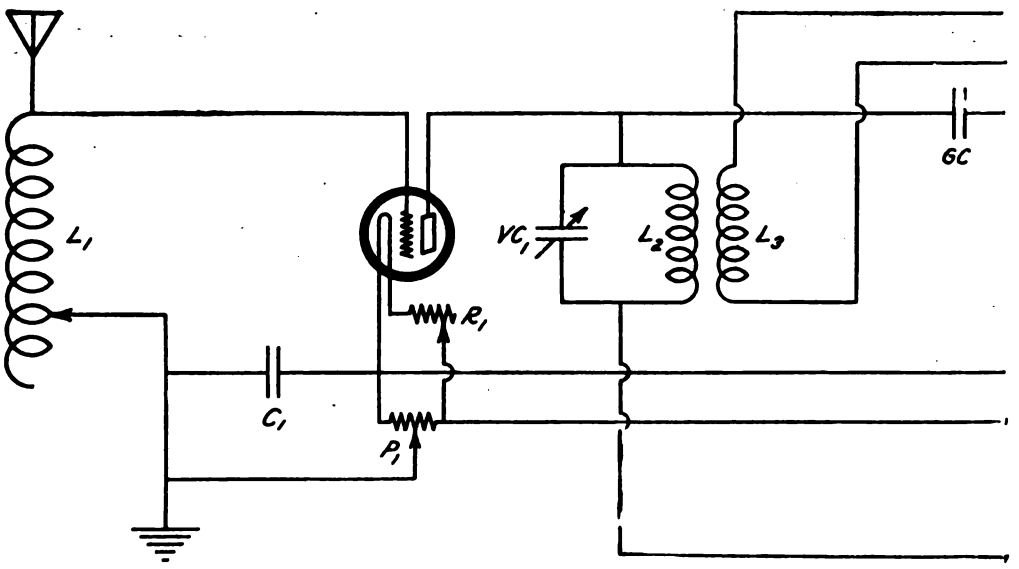

I do is to connect the positive side of the "B" battery to the post marked Positive "B" on the set, as well as to the post marked Positive "A", and the signals come in. Is this something new?

AL. DRUMMOND

ANSWER: No, this is not particularly new. You are utilizing the voltage drop across the filament rheostat for the plate voltage. In other words if you are using a six-volt "A" battery and if the rheostat is only turned up three-quarters of the way you are getting approximately one or two volts on the plate. This is sufficient to operate a set on local signals on most tubes.

* * *

QUESTION: The wonderful results that the English are getting with their receiving sets, in picking up American broadcasting, seem to be dependent upon their use of a peculiar radio-frequency hook-up that I have heard they use almost exclusively. The circuit contains a tuned coil in the plate circuit of the first radio-frequency amplifier, coupled up with the plate coil of the detector tube. I remember seeing the circuit somewhere, but I cannot find it, and would like to know if you are familiar with it. If so will you kindly let me have it with the addition of one stage of audio-frequency amplification?

I would like to try to duplicate some of their results, in my own receiving station.

CHAS. DOWNING

ANSWER: The British tuned-anode circuit using one stage of tuned radio-frequency amplification with a detector feeding back into the tuned circuit and one stage of audio-frequency amplification is shown in Figure 2. The parts you will need are the following:

L1—single slide tuning coil;
L2—honeycomb or duolateral coil, L-50;
L3-honeycomb or duolateral coil, L-75;
VC1—variable condenser, .0005 mfd.;
VC2—variable condenser, .0005 mfd.;
C1 and C2—mica fixed condensers, .002 mfd.;
C3—mica fixed condensers, .0005 mfd.;
P1—potentiometer, 300 ohms;
R1, R2, and R3—filament rheostats;
GC—grid condenser, .00025 mfd.;
GL—grid leak, 2 megohms;
AFT—audio-frequency amplifying transformer.

The first and last tubes should be "hard" tubes and the second tube used as a detector should be either a soft tube or a hard tube.

If a hard tube is used the circuit will be as shown in the diagram, but if a soft tube is used the "B" battery should be tapped at 22½ volts for the detector plate.

The circuit will be found to be selective, and very sensitive to weak signals. The tuning with the two variable condensers is extremely critical and will bring up a weak signal to great strength when properly adjusted.

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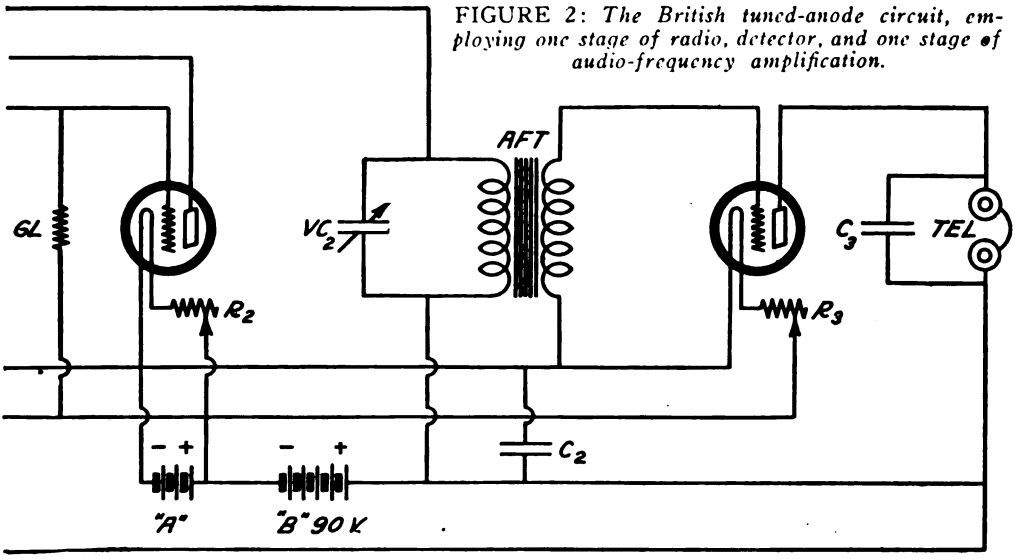

FIGURE 2: *The British tuned-anode circuit, employing one stage of radio, detector, and one stage of audio-frequency amplification.*

QUESTION: Is resistance-coupled amplification as efficient as transformer-coupled amplification for audio frequency work? Does resistance-coupled amplification give more or less distortion of voice signals than transformer-coupled amplification?

AMOS W. CHURCH

ANSWER: Resistance-coupled amplification requires more stages of amplification to obtain a given signal strength than transformer-coupled amplification, although on a properly designed resistance-coupled amplifier there is less distortion, due to the fact that the coupling resistances respond to voice frequencies of different ranges with equal facility. The transformers are always somewhat more apt to respond to voice frequencies of one particular band more than others but in the best transformers this band is widened out to cover the important frequencies in speech and music.

* * *

QUESTION: Can I use a wire about 70 feet long strung along the picture-moulding in my hall to receive from the local stations? I cannot put up an outside antenna, and a friend has offered to sell me a regenerative set and install the indoor antenna along the lines described. I want to know if this will be feasible for reception up to about fifteen miles.

S. D. PERRY

ANSWER: For the short distances over which you want to operate, the plan outlined will be suitable. You should have about two stages of audio-frequency amplification to use with the set for good results, however.

If you want, at some future time, to operate over a wider area, you may also include two stages of radio-frequency amplification which should boost the range up to several hundred miles.

* * *

QUESTION: Does the antenna wire have to be bare copper or can it be coated with any kind of insulation? If the wireless waves can go through anything, I should think that the wire could be covered and yet work just as well. However, when I asked the local expert in our town he said it would not be very good and he was too busy at the counter to tell me why.

A. T. G.

ANSWER: Electrically, the covered wire and the bare wire would be equally efficient, but mechanically the bare wire would be the better. The covered wire would have a greater weight (the weight of the insulation) to carry when arranged in a span, and when it is exposed to the weather for any great length of time, the insulation becomes decomposed and hangs in unsightly shreds and fragments from the copper. The bare copper is the stronger, for a given diameter of wire, looks better, has the same efficiency and, therefore, it is the best to use.

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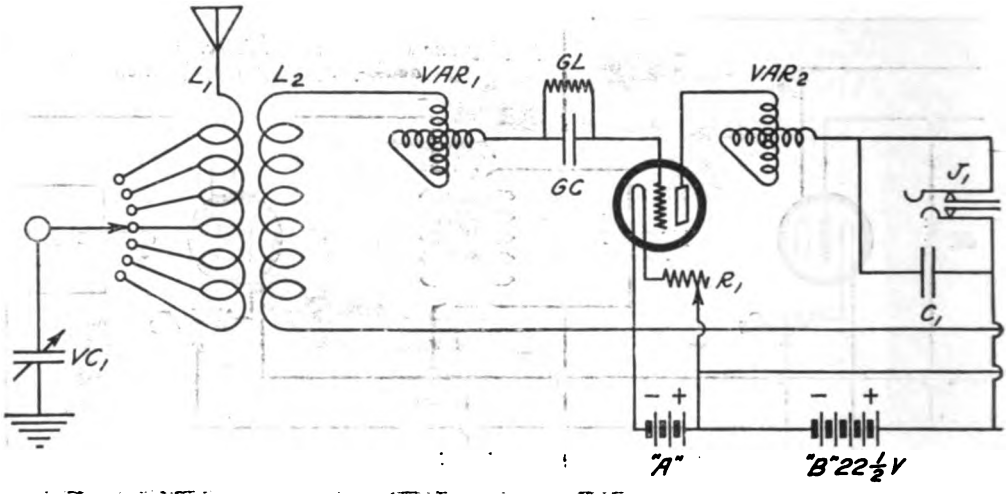

QUESTION: Please give me a circuit diagram showing the proper way to hook-up a variocoupler, two variometers and a two-stage audio-frequency amplifier with a .001 mfd. variable condenser in the ground circuit to further facilitate the sharp tuning of the antenna. Also, please include telephone jacks in the detector circuit, the first stage of amplification and the second stage.

ANDREW JORDAN

ANSWER: The diagram in Figure 3 gives you the proper wiring to use for the standard regenerative circuit. The detector rheostat is included in the positive side of the filament and the amplifier rheostats are placed in the negative side of their respective filaments. This is to insure proper free grid potentials on the detector and amplifier tubes to insure their operation on the part of the characteristic curve where detection and amplification are effected most efficiently.

The other parts you will need are:
GL—grid leak, 2 megohms;
GC—grid condenser, .00025 mfd.;
C1—mica fixed condenser, .0005 mfd.;
AFT1—audio-frequency transformer, high ratio;
AFT2—audio-frequency transformer, low ratio;
R1, R2, and R3—rheostats, 5 or 6 ohms;
"A" and "B" batteries of correct voltages to fit the tubes used.

* * *

QUESTION: In which direction should my antenna point to get stations east and west? Should I put it up running north and south or east and west?

M. W.

ANSWER: To receive east and west, the antenna should be strung east and west. To receive north and south the antenna should be strung north and south. The lead-in should be fastened at the end pointing in the one direction you want to receive from best. To illustrate: If you want to receive in an easterly direction the antenna should be stretched east and west with the lead-in at the eastern end of the antenna.

* * *

QUESTION: How long should the large sized "B" batteries last on a set employing three radiotrons in a regenerative circuit and two stages of audio-frequency amplification if two 45-volt batteries are used and the set is operated for about three hours a night for six nights of the week?

ARTHUR BROWN

ANSWER: The batteries should be serviceable for a period of approximately five months if they are of a reliable make.

* * *

QUESTION: Is transformer coupled radio-frequency amplification as efficient as tuned radio-frequency amplification?

LAWRENCE KENNEY

ANSWER: No. The tuned radio-frequency method is the most efficient because the resonance phenomena which takes place when the plate circuits and grid circuits are in tune makes possible a greatly increased plate current and a correspondingly increased grid voltage on the next tube. This is not so with a coupling transformer that is only roughly tuned to a whole band of wavelengths. The tuned method is still more efficient when some method for preventing feedback is used in conjunction with it, as the circuits may be exactly tuned without being thrown into oscillation.

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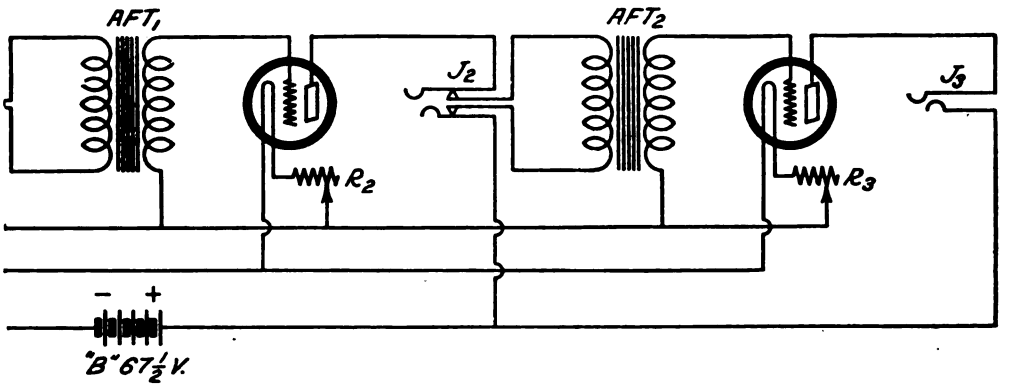
FIGURE 3: *The standard regenerative hook-up which shows how to use a vario-coupler, two variometers and a variable condenser with two stages of audio-frequency amplification.*



QUESTION: I would like to get a hook-up of the modified Colpitt's circuit for receiving with one bulb and a honeycomb coil. Please tell me the correct capacity of the condensers necessary to use with this circuit, if any.

R. B. MANY

ANSWER: You will find the circuit you have asked for in Figure 4. You will require one variable condenser, VC, of .0005 mfd. capacity, for tuning and one fixed condenser, GC, of the same capacity for the grid circuit. The grid condenser should have a capacity of .00025 mfd. and coil, L1, is a honeycomb or duolateral, size L-50. All the tuning is done with the condenser, VC, and the regeneration is controlled by the 6-ohm rheostat, R.

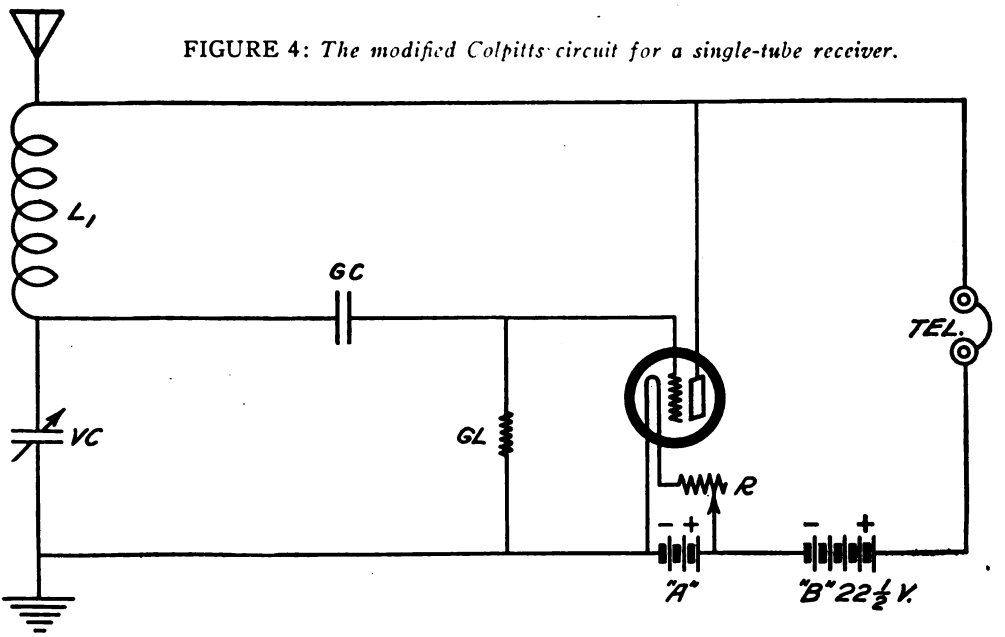
* * *

QUESTION: Is it possible to use a loop antenna with the four-circuit tuner? I find that I will be unable to put up an antenna on the roof.

A. N. TAYLOR

ANSWER: In a near future issue of POPULAR RADIO there will appear an article describing a modification of the four-circuit tuner which employs a loop of special design. The set will operate a loudspeaker and operates on three dry-cell tubes.

FIGURE 4: *The modified Colpitts circuit for a single-tube receiver.*



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If you are getting good results with your receiving set, tell your fellow-readers of POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

NEW WAVES HELP HIM

BECAUSE of the new arrangement of waves, J. Schwartz of Revere, Mass., is able to hear 75 stations with little interference when using only two tuning instruments. His record was obtained during a period of three months, using a variocoupler, a variable condenser and a UV-200 tube.

Care in erecting his antenna, he thinks, is responsible for part of his record. It is made of two wires each 75 feet long, with a 30-foot lead-in. One end of his antenna is 35 feet high while the other is only 20. He heard CJCB, Nelson, B. C., 2,400 miles away; CJCA, Edmonton, Alta., Can., 2,350 miles; PWX, Havana, Cuba, 1,500 miles; CKCK, Regina, Sask., Can., 1,775 miles; WPA, Fort Worth, Tex., 1,650 miles; WDAF and WHB, Kansas City, Mo., 1,300 miles; WEAV, Rushville, Neb., 1,700 miles, and seventeen other stations more than 1,000 miles away.

* * *

THIRTEEN STATIONS TO THE PINT

"You may not believe it," begins Victor Wade Sandberg of Mont Belvien, Texas, "but I receive thirteen stations with a crystal and a coil I wound on a pint glass jar."

He is fourteen years old and he made his double-slide tuner himself. The stations he heard, most of them at night, are WEAY, Houston, Tex.; WJB, Austin, Tex.; WFAA, Dallas, Tex.; WBAP, Fort Worth, Tex.; WOAI, San Antonio, Tex.; WHAB, Galveston, Tex.; WHB and WDAF, Kansas City, Mo.; KSD, St. Louis, Mo.; WOC, Davenport, O.; WMC, Memphis, Tenn.; WXY, Birmingham, Ala., and WOS, Jefferson City, Mo.

* * *

WHAT ONE CRYSTAL DID

A CRYSTAL set made entirely at home by C. E. Van Kirk, Saint Paul, Minn., has picked up WOC, Davenport, Ia.; KDKA, Pittsburgh, Pa., and a number of closer stations.

A CRYSTAL DETECTOR ON THE HIGH SEAS

R. H. FREY, chief operator aboard the S. S. *Eilago,* reports hearing WWJ of Detroit, Mich., while listening at the ship's crystal set while the ship was approximately 250 miles southeast of Cape Hatteras, a distance of 1,100 miles.

* * *

GOOD WORK ON A SIMPLE SET

WITH little more than "a rag, a bone and a hank of hair," Edward Foster of Dearborn, Mo., hears 32 stations. He has a wire, a phone, a "hank" of pasteboard tubing and a crystal. The sliding coil tuner is his own make, and with a wire 160 feet long for an antenna, he hears WSB, Atlanta, Ga.; WSY, Birmingham, Ala.; WGY, Schenectady, N. Y.; WFAA, Dallas, Tex., and WHD, Morgantown, W. Va.

* * *

A SINGLE TUBE TAKES HIM A LONG WAY

IN regard to covering great stretches of territory with a single tube, R. E. Jones, Jr., of Bay City, Mich., mentions the fact that his set reaches 2,300 miles to KPO, San Francisco, Cal. In order to cover the distance he employs a single-circuit tuner at the sacrifice of considerable selectivity. He uses a variocoupler and a 23-plate condenser.

In his list of eighty-one stations in twenty-five states are KFI, Los Angeles, Cal.; CHBC, Calgary, Canada; WCAR, San Antonio, Tex.; KFDF, Casper, Wyo.; KFAF, Denver, Colo.; WWL, New Orleans, La.; WFY, Wichita, Kans., and WKY, Oklahoma City, Okla.

* * *

HEARING ACROSS THE PACIFIC ON A GALVANIZED IRON ROOF

USING the roof of his house as his antenna, S. G. Lewis, of Hobart, Tasmania, claims that he has heard signals which came from stations in places as far distant from him as Manila and Panama.

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HE LIKES HIS SINGLE CIRCUIT

USING two duolateral coils in a unique regenerative circuit, Frank D. Stagio of Brooklyn, N. Y., says he receives over great distances without interference which is usually encountered in the use of a single-circuit tuner.

He has received KDKA of East Pittsburgh, Pa., with his detector tube alone, and local stations can be heard a dozen feet from his phones.

With a primary coil of 50 turns and tickler coil of 35 turns, he covers all wavelengths from 150 to 600 meters. His two variable condensers, one of which is in the ground circuit, and the other in series with the tickler are of .0005 mfds. capacity.

Using two stages of audio-frequency amplification and a loudspeaker, he receives the following stations loud and clear without interference from local stations: KYW, Chicago; WDAP, Chicago, Ill.; WCX, Detroit, Mich.; WOO, Philadelphia, Pa., and NAA, Washington, D. C.

* * *

HE LIKES ONE STAGE OF AUDIO

WITH but one stage of audio-frequency amplification, Rodney Plimpton of Southbridge, Mass., has heard 22 stations within his first three months.

His antenna consists of one wire 125 feet long, with a 25-foot lead-in. His set employs three honeycomb coils in the usual regenerative circuit.

His best records are WSB, Atlanta, Ga.; WMAQ, Chicago, Ill.; WKAZ, Wilkes-Barre, Pa.; WDAP, Chicago, Ill.; WOC, Davenport, Ia.; WSY, Birmingham, Ga.; 3XW, Parkesburgh, Pa.; WDAR, Philadelphia, Pa.; WMC, Memphis, Tenn.; WOAW, Omaha, Neb., and CFCF, Montreal, Canada.

SURPRISED BY HIS CRYSTAL SET

"A FEW nights ago," writes W. C. Robbins of Okmulgee, Okla., "while listening in with my single-slide crystal set I was surprised to catch the last few bars of *The Star Spangled Banner* played on a violin. I knew of no station near me that was broadcasting that night. I called up the local station and asked if they were broadcasting, and was told that the music had come from Kansas City, Mo. It was hard to believe, as Kansas City is 200 miles away, but I listened again and heard the announcer. I was still more surprised when later I heard a program from St. Louis, Mo., more than 400 miles away.

"I can't always do this, but the fact that it is sometimes possible makes me think that a crystal set is not so much to be despised after all."

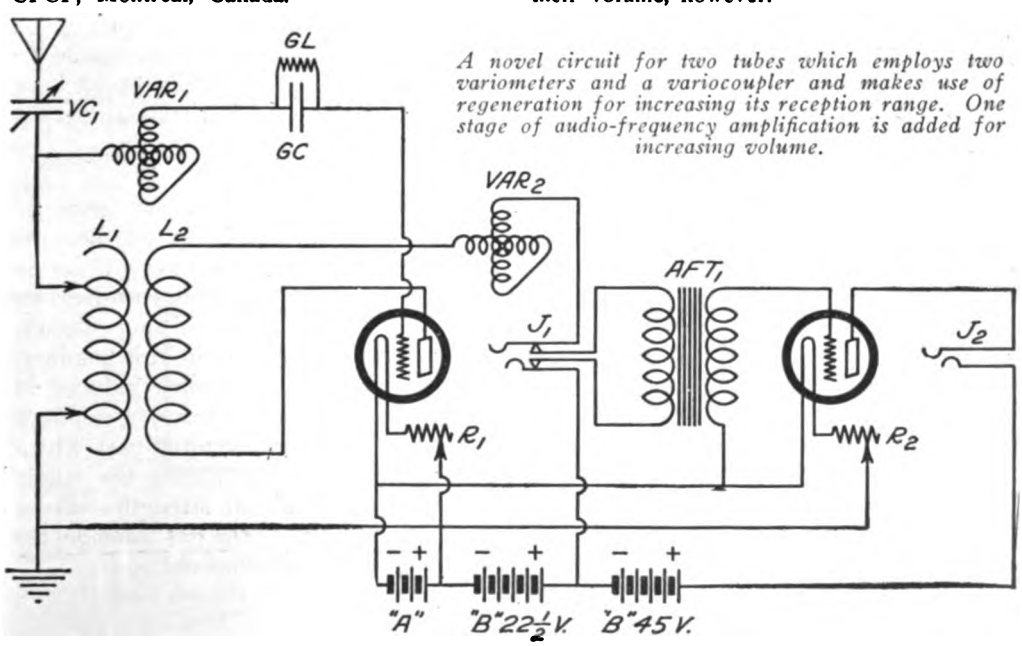
* * *

NAVY HOOK-UP MAKES A RECORD

FROM his home in Mechanicville, N. Y., Robert Irwin reaches to Porto Rico and to Nebraska with two dry-cell tubes, and believes that his luck is due to a navy hook-up which employs a variocoupler, two variometers and a 43-plate condenser in a manner somewhat out of the ordinary.

His record includes WKAQ, San Juan, Porto Rico; WOAW, Omaha, Neb.; WMC, Memphis, Tenn.; WDAJ, College Park, Ga.; WSB, Atlanta, Ga.; CFCA, Toronto, Can.; CHYC, Montreal, Can.; WDAP, Chicago, Ill.; KSD, St. Louis, Mo.; WLAG, Minneapolis, Minn.; WHA, Madison, Wis.; WHAS, Louisville, Ky.; WWJ, Detroit, Mich., and WDAL, Jacksonville, Fla.

All of the stations he hears except WKAQ, were received on one tube. His single stage of audio-frequency amplification increases their volume, however.



A novel circuit for two tubes which employs two variometers and a variocoupler and makes use of regeneration for increasing its reception range. One stage of audio-frequency amplification is added for increasing volume.

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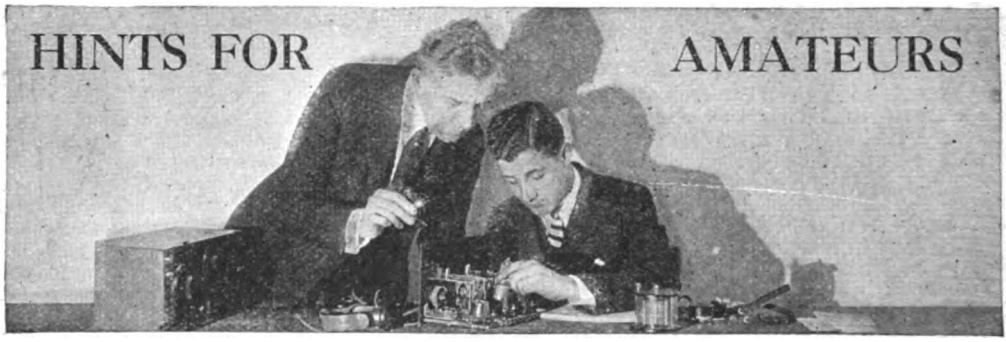

In finishing a radio cabinet with an open grained wood such as chestnut, ash or oak, it is a comparatively easy job to give it an antique gray finish. This finish is permanent and has a good appearance.

Rub the wood down with a little linseed oil, and clean off with a cloth until the surface of the wood is dry. Then fill the grain of the wood with a filler made of white lead mixed with lampblack so that it is colored a light gray.

When the filler has hardened in the grain the whole surface should be rubbed down again, with fine sandpaper, until it is smooth and then a wax finish put on with a cloth.

* * *

Never run the antenna lead-in any long distance through the house. Make it as short as possible from the window where the wire is brought in. If the lead-in is long inside the house the walls and ceilings will absorb most of the radio-frequency energy that should be used in the set for producing signals; in other words the signals will be much reduced in strength.

Place the receiving apparatus near the window and run the ground wire to a *waterpipe!*

* * *

Gassy tubes such as used for detectors function at plate voltages between 16½ volts and 22½ volts; usually they function best at a plate potential of about 18 volts.

Hard tubes, when used as detectors usually function best at plate potentials of about 45 volts and as amplifiers at plate potentials of 90 volts or more according to the type of tube used.

* * *

Do not paint any of your radio instruments or coils; leave them dry.

* * *

When a 100-foot antenna is specified for use with a certain receiving set, the 100-foot length refers to the length from the spot where the lead-in joins the horizontal wire to the furthest tip of the antenna.

To illustrate: In an antenna with a horizontal wire 100 feet long, if the lead-in were taken off at one end, the antenna would be referred to as a 100-foot antenna. If the lead-in were taken off at the center, the antenna would be only a 50-foot antenna. It would have about the same characteristics as a two-wire antenna 50 feet in length.

* * *

When using SCC copper wire to wind coils for a receiving set, be sure that the insulating wrapping of cotton is not damaged, as this may cause two adjacent turns of wire to short-circuit. If two turns do touch in this manner, the radio-frequency currents induced in the coil will induce a heavy secondary current in the short-circuited part which will drop the voltage across the whole coil so that the signal strength will be materially lowered. *Do not damage the insulation when winding the coils.*

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It will assist in obtaining quiet reception, without any extraneous noises, in a radio receiver, if a .5 mfd. fixed condenser is connected across the "A" and "B" batteries as shown in the diagram on this page.

* * *

Be sure that you obtain a good grid condenser and reliable grid leak, as these two instruments, more than any others in the set, will determine the sensitivity of the receiver as a whole.

* * *

When trying out a receiver for the first time, try out one tube in each of the sockets, one socket at a time, with all the batteries connected. In this way, if you have made a wrong connection, you will burn out only one tube instead of all the tubes in the set; but first make sure that you have everything hooked up correctly.

* * *

Do not erect your antenna either over or underneath any sort of power wires, because the power wires may carry a dangerous voltage, and if they or the antenna fall while the set is being used the operator may receive a serious shock.

* * *

Never charge your battery without disconnecting it from the receiving set. If you leave it connected to the set, and turn on the charger, you may expect to blow out the line fuses, or the tubes. This is because one side of the lighting line is grounded, and as the filament circuits in most receiving sets are also at ground potential, you may expect to see or hear fireworks.

* * *

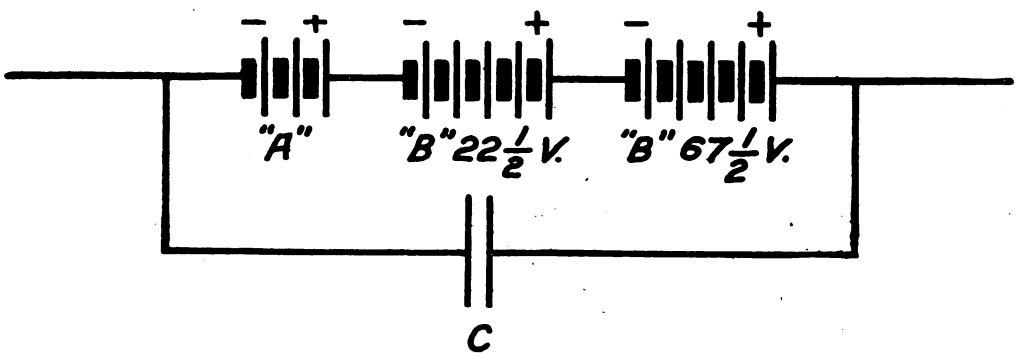
Do not oil the levers on the rheostats used in the set for making contact with the resistance unit. This will finally result in "frying" noises in the receivers, due to the varying resistance junction formed when the oil heats up and carbonizes. The rheostats now on the market are correctly designed to work without any form of lubrication between the lever and the resistance wire.

* * *

A loop antenna cannot be used with any real success with a crystal detector or non-regenerative vacuum-tube circuit unless used in conjunction with radio-frequency amplifiers. A regenerative vacuum-tube circuit will give only fair results with a loop, for local reception, unless it is used with audio-frequency amplifiers.

* * *

Don't try to make an amplifying transformer for audio-frequency amplification. In the end you will give yourself a lot of trouble and will be able to produce an instrument of only inferior quality. Buy one of the reliable standard makes and get a good instrument.



A fixed condenser, of approximately one-half microfarad, connected across the "A" and "B" batteries will keep out battery noises from your set.

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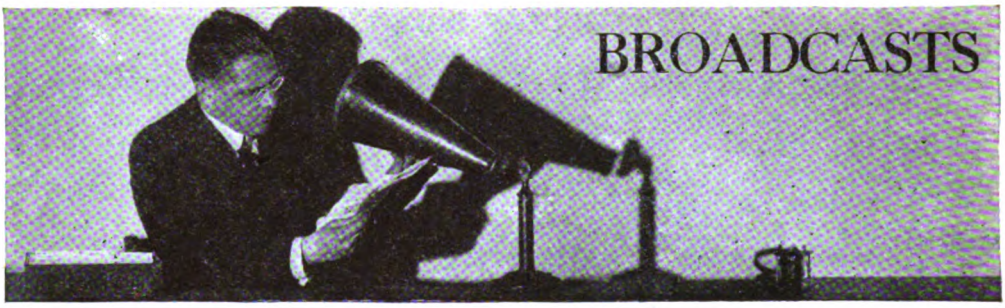

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

Radio Announces the President's Death

ONCE again radio played an important part in the dissemination of news of a national character, when President Harding died in San Francisco on August 2nd. The President's death occurred at 7.30 P.M., Pacific time, and the Associated Press had the story out within five or ten minutes, the report being received at the Washington office of that organization at 10.55 P.M., eastern standard time, or twenty-five minutes after Mr. Harding died. The first intimation the general public had of the President's death, however, was when various newspapers with broadcasting licenses sent out the Associated Press dispatch. As a result of the broadcast announcement, the news of the President's death was generally known from thirty minutes to two hours before the newspapers in the larger cities were on the street with an extra.

* * *

Have We Passed the Peak in Number of Broadcasting Stations?

THE number of broadcasting stations is apparently subsiding. The peak of the curve of this popular service was reached in May, when 591 stations were on the lists of the Department of Commerce. On June 30, there were 573 or 18 fewer stations than in May, although there were 115 more than in June, 1922.

On June 30 the total of 573 stations was distributed as follows: Class A, 203; Class B, 42; Class C, 327; and Class D (development), 1.

* * *

Radio Saves Uncle Sam $20,163

ALL War Department telegrams, cablegrams and radio messages are handled directly through the Army Message Center, located in the Munitions Building, and under the direction of Major-General George O. Squier, Chief Signal Officer of the Army. An average of 322 messages a day is now handled, the bulk of the dispatches being sent and received by radio. As a financial saving to the government, the Message Center is a unique factor. Through the operation of its radio net it has reduced the telegraph tolls from $5,500 in July, 1922, to $1,650 in March, 1923. Through the use of its radio net, now including 112 stations in every corner of the country, the Message Center handled 62,222 official radiograms, totaling 2,235,417 words, during the last calendar year. If this traffic had been handled over commercial telegraph lines, the cost to the government would have been $38,202, but the army cost was only $18,039, exclusive of enlisted operating personnel. The saving to the country amounted to $20,163.

* * *

The Nine Radio Inspectors

EVERY amateur and broadcaster should know the officials of the Radio Section of the Department of Commerce in his district, so that he can get advice, keep in touch with new regulations and not be imposed upon by bogus representatives.

At headquarters in Washington, Chief Supervisor of Radio W. D. Terrell is in charge under Secretary Hoover and Commissioner Carson. Mr. Terrell is assisted by W. E. Downey, Supervisor of Radio. In the nine districts with headquarters as shown, the following men are in charge:

District	*Headquarters*	*Supervisor of Radio*
1st	Boston	C. C. Kolster
2d	New York	Arthur Batcheller
3d	Baltimore	R. Y. Cadmus
4th	Atlanta	R. Y. Cadmus (until relieved by Van Nostrand)
5th	New Orleans	Theodore G. Deiler
6th	San Francisco	J. F. Dillon
7th	Seattle	O. R. Redfern
8th	Detroit	S. W. Edwards
9th	Chicago	E. A. Beane

* * *

Broadcasting Stations Break Into Mexico

Two radio-telephone broadcasting stations were recently opened in Mexico City, Consul Thomas D. Bowman, reports. Various efforts have been made in recent months to obtain concessions for the establishment of such stations, but it is only recently that the government granted permission. It is reported that other broadcasting stations are to be erected in Mexico.

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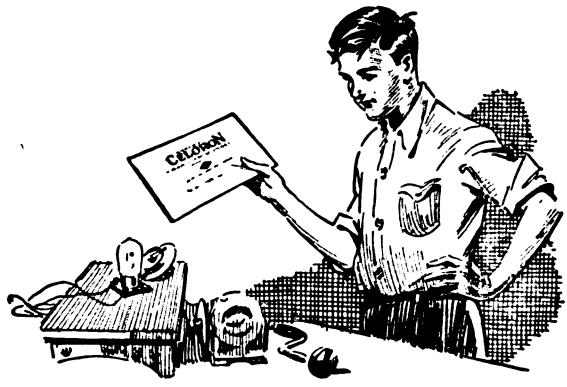

"What panel shall I use?"

ONE of the first questions you probably will ask yourself when you get ready to build your radio set will be about the choice of a good panel. Your answer will determine, to a large extent, the efficiency of your set.

Of course you want a panel that has superior insulating properties. Celoron Radio Panels are used by fans who appreciate the value of a good radio panel. They have high dielectric strength and great volume and surface resistivity. Celoron panels are uniform in quality, and do not warp or crack.

You will find Celoron panels easy to saw, drill, and tap. They engrave evenly without feathering, and enable you to build a set that is neat and attractive as well as efficient.

Approved by Uncle Sam

Celoron Radio Panels are approved by the U. S. Navy Department Bureau of Engineering and the U. S. Signal Corps. Many of the leading manufacturers of radio equipment use Celoron in their standard parts.

Each panel is wrapped separately in glassine paper and carries complete instructions for working and finishing. Ask your dealer for one of the following sizes:

1—6 x 7 x $\frac{1}{8}$	5—7 x 18 x $\frac{3}{16}$
2—7 x 9 x $\frac{1}{8}$	6—7 x 21 x $\frac{3}{16}$
3—7 x 12 x $\frac{1}{8}$	7—7 x 24 x $\frac{3}{16}$
4—7 x 14 x $\frac{3}{16}$	8—12 x 18 x $\frac{3}{16}$

We also furnish Celoron in full-sized sheets and can cut special sizes if desired. If your dealer has not yet stocked Celoron panels, ask him to order for you, or write direct to us. Indicate by number the size you want.

Send for free booklet

Our booklet, "Tuning in on a New World," contains a list of the leading broadcasting stations in the United States and Canada, several efficient radio hook-ups, and an explanation of the symbols used in radio diagrams. Write at once and be sure of getting yours before the supply is exhausted.

To radio dealers: Send for special dealer price list showing standard assortments

Diamond State Fibre Company

BRIDGEPORT (near Philadelphia) PENNSYLVANIA

BRANCH FACTORIES AND WAREHOUSES

BOSTON CHICAGO SAN FRANCISCO

Offices in Principal Cities

In Canada: Diamond State Fibre Company of Canada, Limited, 245 Carlaw Ave., Toronto

CONDENSITE CELORON STANDARD RADIO PANEL

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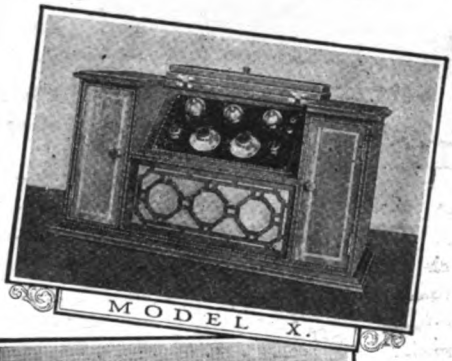
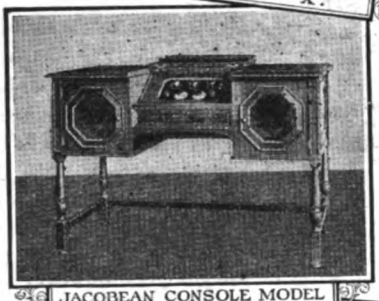
The Royalty of Radio

New Additions *to*



MODEL X.



JACOBEAN CONSOLE MODEL

SPANISH DESK MODEL

Beautiful New Furniture Models—Simplified Tuning—Self-contained

The three new Kennedy Furniture Models illustrated on this page are the very last word in radio receiving sets. Even if attention were drawn no further than their exterior beauty, their purity and harmony of design alone would be instantly appreciated.

The receiver in each is a new achievement of the Kennedy Engineering Staff. Extreme simplicity of tuning is attained with the same selectivity and long-distance reception that have made Kennedy sets so well and favorably known. Only two dials are used—one for "tuning in" or selecting the desired station, the other to control sound volume. Adjustment is provided for very fine tuning.

These models are complete and self-contained. They operate on dry battery tubes for which internal space is provided, although any standard tubes—including storage battery type—may be used. Two stages of audio amplification—built-in loud speaker with unusually clear and distortionless qualities of reproduction. Highly polished Formica control panels. Gold-plated metal trimmings on front—including dials. Respond to all broadcasting wave-lengths. Each complete with three dry-battery tubes, all dry batteries and Kennedy 3000-ohm phones with plug, for individual reception.

Kennedy Model X. Beautiful hand rubbed Mahogany cabinet with inlay of Satin Wood and Ebony. The tracery, in delicate contrast with background, is suggestive of the marquetry workers of King William's time. Price, complete.....$285.00

Kennedy Jacobean Console Model. Exemplifies the late Jacobean design. Built of American Walnut with artistically matched paneling, which contributes the rich subdued effect almost always associated with true elegance. Price, complete.....$775.00

Kennedy Spanish Desk Model. An adaptation of the Spanish with a free intermingling of the effects of the Moorish influence. This is particularly in evidence in the panel. Cabinet finished either in Mahogany or American Walnut. Interior lined completely with Golden Bird's-eye Maple. Price, complete....$825.00

KENNEDY

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The Royalty of Radio

the Kennedy Line

A New Popular-Priced Model, Head Phones and Loud Speaker

he apparatus shown on this page is of the same gh character as the more elaborate Furniture odels. The sets were designed to fill the demand r high quality at a popular price, and, with the onderfully improved head phones and separate ud speaker unit, they provide Kennedy apparatus r every home.

ennedy Model V. Incorporates the new Kennedy receiver d two-stage amplifier at moderate cost. Same type of radio it as higher priced Furniture Models, but without loud eaker. Highly polished Formica control panel. German ver dials. Space for batteries. All dry batteries, three dry-ttery tubes and Kennedy phones with plug, complete..$125.00
eceiver only, without phones, tubes or batteries....$ 86.50

ennedy Type-281. One of the sets that has won recogni-on for the Kennedy line. An extremely selective three-rcuit receiver. Solid Mahogany cabinet. Brilliantly polished ormica control panel, black etched dials, heavily nickel-plated etal parts. Wave-length range 175 to 900 meters. Designed r 6-volt tubes but can be used with dry-battery tubes as well.
eceiver only.....$ 90.00
eceiver and two-stage audio amplifier.....$145.00

ennedy Type-311, 522 Portable. Neat, compact, portable. asily tuned—highly selective and efficient. Designed for all andard tubes, including dry-battery type. Detector and two ages of audio amplification. Wave-length range 150 to 600 eters. Complete with three dry-battery tubes, all dry atteries and Kennedy phones, with plug.....$137.50

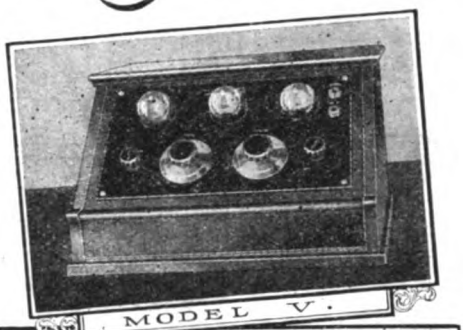
Kennedy Loud Speaker. The same as used in the new Kennedy Furniture Models. Remarkable fidelity of repro-luction with total absence of unpleasant distortion. No eparate batteries required. Price, complete with 6 ft. cord..$30.00

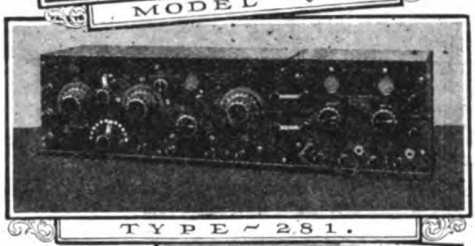
Kennedy Head Phones. Perfection in mechanical and lectrical design results in unusual volume with rich tonal urity. No rattle or blare. Extremely sensitive on weak and listant signals. Light and snug fitting. Resistance 3000 ohms. rice per set, with 6 ft. cord.....$9.00

See the new sets and parts at the nearest Kennedy dealer or write us direct for literature. State type of set in which you are interested.

DEALERS Write or wire for exclu-sive Kennedy proposition.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS SAN FRANCISCO





All Kennedy receiving sets are regenerative—Licensed under Armstrong U. S. Patent No. 1,113,149.

7

KENNEDY

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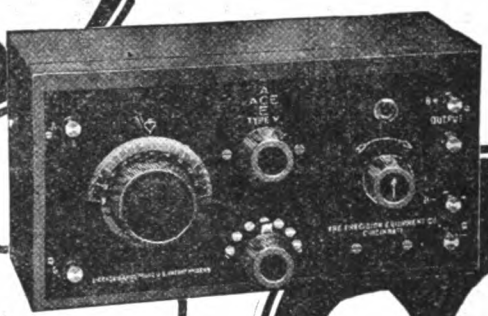
$20 Distant Reception at Lowest cost

Armstrong Regenerative Receiver

Licensed under Armstrong U. S. Patent No. 1,113,149



ACE TYPE V

FORMERLY CALLED ~~CROSLEY~~ MODEL V

THE ACE Type V is a long range regenerative radio receiver. Signals received on it are clear and distinct. Stations from coast to coast are heard under ordinary conditions by owners of this set. Wonderful efficiency, simplicity of operation and low cost are the chief factors in the growing success of this receiver. They are the things that have made it the most popular on the market. Thousands of the Ace Type V have been sold, and hundreds of letters from the owners are proof of their success. Can be used with dry cell or storage battery tubes.

Those who desire to operate a loud speaker in connection with the Ace Type V later can add an Ace Type 2 B, a new two-stage audio frequency amplifier, to the set. Then music or voice being received from a far-away station will be heard throughout the room or house. The price of the Ace Type 2 B amplifier is $20.00.

If your dealer cannot supply you, order direct, mentioning his name. Ask for "Simplicity of Radio." Your copy is FREE.

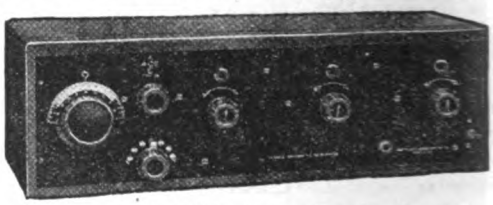
DEALERS—Write on your letterhead for attractive sales proposition.

THE PRECISION EQUIPMENT COMPANY

Powel Crosley Jr. PRES.

1016 Vandalia Ave. Cincinnati, Ohio

The New Ace Type 3 B



A new member of the Ace family selling for $50, which is equal to a combination of the Ace Type V and the Ace two-stage amplifier. Like the Ace Type V it is manufactured under Armstrong U. S. Patent No. 1,113,149. This set is new, but months of research work have brought it to a high degree of perfection. Out-performs receiving sets costing great deal more. A filament switch eliminates necessity of turning out rheostats when set is not in use. A person hearing a broadcasting station may turn off the set by throwing switch and come back later without retuning. A telephone jack is between first and second stage of amplification. This is for use of persons who desire to use head phones instead of loud speaker. Crosley Multistats, universal filament control rheostats for all makes of tubes, also are used in the Type 3B. **Price, $50**

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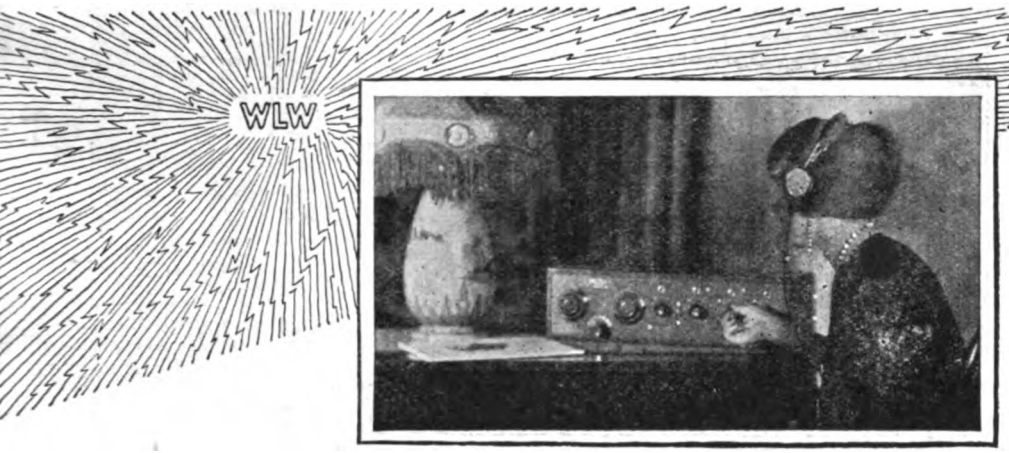


Announcing—
THE NEW CROSLEY MODEL X-J
PRICE $65.00

The Crosley Model X, has in just a year's time established itself as the most popular and successful receiver ever marketed. Hundreds of unsolicited endorsements like the following constantly come to us. A man writing from Belleville, Kansas says:

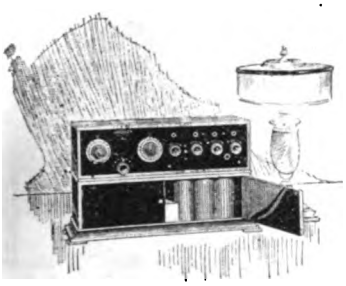
"I have found the Crosley Model X to be the best radio receiving set I have used and permit me to say that I have been interested and using radio sets since spring of 1922 including all standard makes."

Now comes a companion, the new Crosley Model X-J, embodying all the good points of the Model X together with greater refinement of detail. Some of the new features of this wonderful receiver which make for greater distinction and beauty are:

1. ***KNOBS AND DIALS***—larger, easier to control and better looking.
2. ***FILAMENT CONTROL SWITCH***—snaps filaments on and off.
3. ***JACK***—allows you to plug in with head phones on three tubes. When tuned in, just pull the plug and you are switched to the loud speaker.
4. ***ELIMINATION OF BINDING POSTS ON FRONT PANEL.*** By removing the binding posts to the rear, the beauty of the set is greatly enhanced.
5. ***SOCKETS***—Porcelain sockets are replaced with black compound sockets which are just as efficient and better looking.
6. ***CONDENSER***—The New Molded Crosley Condenser made of specially prepared compound will out-perform any condenser on the market.
7. ***MULTISTAT***—Allows the use of all makes of tubes. (Now a feature of the standard Model X).
8. ***RFTA COIL***—New low resistance coil permits sharper tuning.

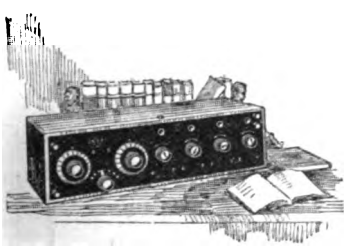
Write for Descriptive Pamphlet

For Sale By Good Dealers Everywhere



CROSLEY MODEL X-J
With Battery Cabinet

This combination makes the set completely self-contained. The batteries are housed in this handsome mahogany, wax finished cabinet. Price of cabinet alone—$16.00.



CROSLEY MODEL X

This remarkable receiver—still priced at $55.00—contains many new features such as the R. F. T. A. Coil and the Multistat. The battery cabinet, illustrated above, may be fitted to it, thus adding to its present beauty.

CROSLEY MANUFACTURING CO.

1016 Alfred Street **Cincinnati, Ohio**

New York Office, C. B. Cooper, 1803 Tribune Building, 154 Nassau street, Beekman 2061
Boston Office, B. H. Smith, 755 Boylston street, Room 316.
Chicago Office, 1311 Steger Bldg., 28 E. Jackson Blvd., R. A. Stemm, Mgr.
Philadelphia Office, J. H. Lyte, 65 North 63rd street.
St. Louis Office, Rob't W. Bennett Co., 1326 Syndicate Trust Bldg.

CROSLEY
Better-Cost Less
Radio Products

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MU-RAD RECEIVERS

The Ultimate in Radio Reception

By this signal from afar off,
Bending like a wand of willow,
Gitche Manito, the mighty,
Calls the tribes of men together.

—"The Song of Hiawatha," *Longfellow*

The New Star in the Radio World

GIFTS FROM THE GREAT SPIRIT" said Iron Hawk, the famous Sioux chief, of the Indians' means of communication. The final perfection of this great gift to mankind is radio. The new science attains its *ultimate* in MU-RAD RECEIVERS. The MU-RAD owner lives in close touch with a vast radius of 4300 miles and more. Time is eliminated. Distance is only geographical. Reception conservatively guaranteed—*1000 miles, using only a 2 foot loop aerial.*

WRITE FOR LITERATURE

MU-RAD LABORATORIES, INC.

809 FIFTH AVE. ASBURY PARK, NEW JERSEY

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The Greatest Advance in Radio Since Radio

Weighs 6 lbs.

PATENTS PENDING

6" square

BASUB uses electric light current (AC) in place of storage battery or dry cells for the "A" battery of any radio set for radio frequency, detection, and audio frequency

Buy a Basub power unit for your present set, or have your new set furnished with Basub built in as an integral part, and so insure uniform voltage and consistent service without recharging or testing.

No tubes, acids or sulphated terminals.
Can be mounted in any position.
Furnishes 75 watts output.

Various models to cover the entire field of commercial voltages and cycles, $30 to $35.

If your dealer hasn't Basub, send us his name and address

Simplex Electrical Laboratories, Inc.

144 Livingston St., Brooklyn, New York City

We will Exhibit at Booth 58, American Radio Exposition, Grand Central Palace, New York City, October 6th to 13th, 1923

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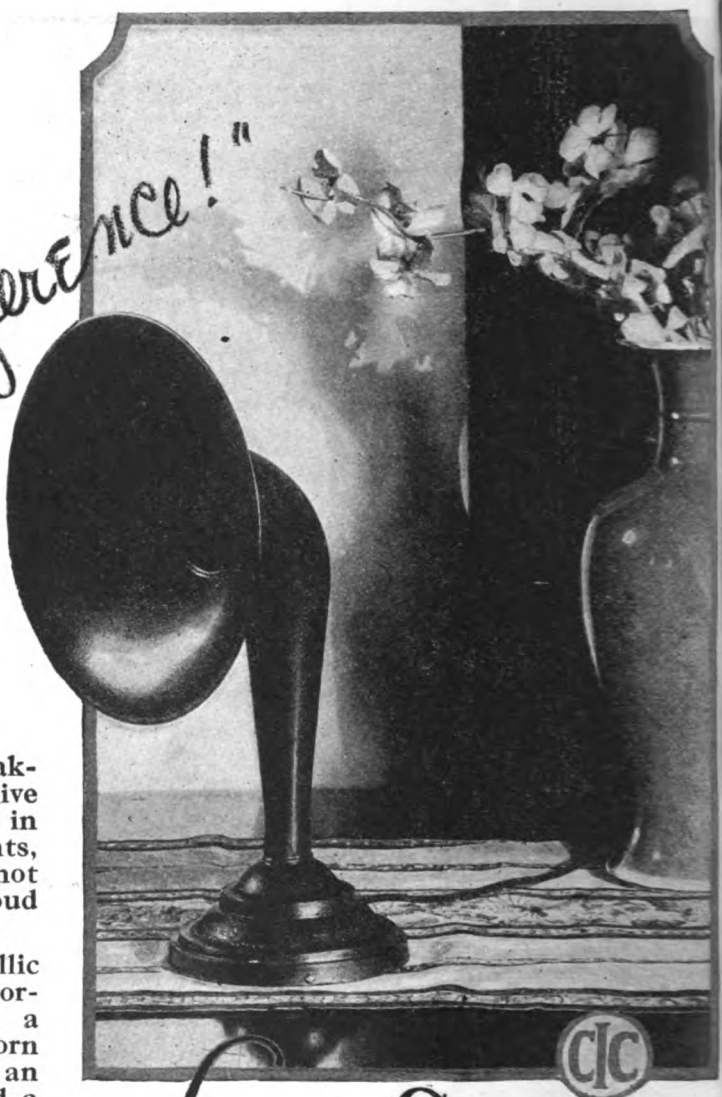
"Listen to the Difference!"



THE C.I.C. Loud Speaker at $14.50 will give a volume found only in expensive instruments, and a quality of tone not equalled by any other loud speaker on the market.

It has a non-metallic diaphragm giving distortionless reproduction, a pipe organ metal horn giving pure clear tone, an adjustable air gap and a beautiful finish similar to a fine grained Morocco leather.

It is unconditionally guaranteed.

Write for our pamphlet "Loud Speaker Facts"

CIC Loud Speaker Facts

CONNECTICUT INSTRUMENT CO.

STAMFORD, CONN.

Distributed in Canada by **Perkins Electric Ltd., Toronto, MONTREAL, Winnipeg**

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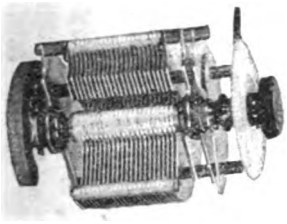

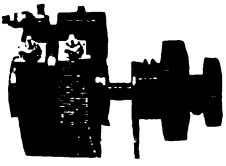

Whether You "Build Your Own" or Buy Complete Sets— Rely on De Forest!

BEFORE anyone else was thinking of radio, nearly a quarter of a century ago, Dr. Lee De Forest was doing the first radio broadcasting.

All during the development of the art the De Forest Company has been making the laboratory tested parts, out of which experts all over the United States made their experimental sets.

When radio became popular the people in general found out that if a part was marked "De Forest"—it *worked.*

During the "rush months" when radio production couldn't catch up with the demand, De Forest parts were still manufactured with that painstaking care and exactness and knowledge of electrical science which mean the best possible kind of service to the user.

The De Forest name has always been too famous for the De Forest Company to allow anything to go out which was not laboratory tested and guaranteed to function.

Ask the De Forest Agent to show you the laboratory tested De Forest parts. Ask him to tell you about the various hook-ups which are possible. If you are interested in complete sets let him show you the famous De Forest Reflex, whose range on indoor-loop varies from 1,500 to 3,000 miles, according to atmospheric conditions, and which is known all over the country for clearness of reception and unusual ease of control.

Whether you "build your own" or buy complete sets, rely on De Forest —the most famous name in radio.

Send us a postcard for the free De Forest catalog with complete details of sets, parts, and the perfected De Forest dry cell and wet cell audions.

DE FOREST RADIO TEL. & TEL. CO.
Dept. P. R. 2 Jersey City, N. J.

If located west of Pennsylvania, address

DE FOREST RADIO TEL. & TEL. CO.
WESTERN SALES DIVISION
Dept. P. R. 2, 5680-12th St. Detroit, Mich.

De Forest Products are sold only through exclusive agents, direct to the public for your protection. The De Forest Company will be glad to hear from representative dealers in various communities who wish to become exclusive De Forest agents.

Illustrated above are the De Forest Vernier Variable Condenser, $15.60; the De Forest Combination Audion, $5.00; the De Forest Tube Socket, 80c., and the De Forest Combination Rheostat and Potentiometer, $2.00. Prices plus approximately 6% for transportation west of the Rockies.

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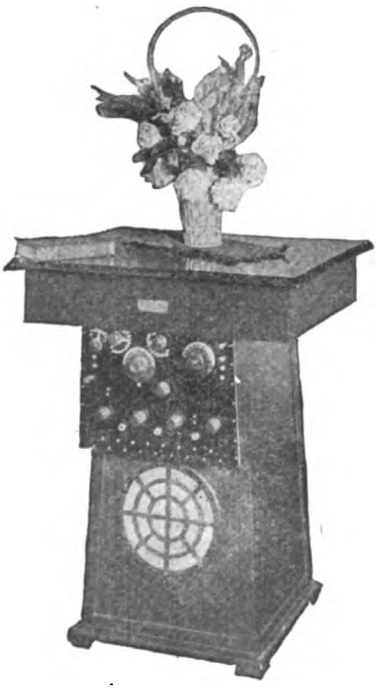
U.S. TOOL CONDENSERS

Plates and Spacers Chemically Treated to Prevent Oxidizing

THE greatest enemy of condenser efficiency—oxidizing of plates and spacers—is conquered in *U. S. Tool Condensers*, by an exclusive chemical process. Years of continual use and exposure leave these condensers unharmed—as perfect as the day they were purchased. Built to maintain a reputation, gained through years of honest manufacture.

Write for illustrated booklet and the name of the nearest U. S. Tool dealer—TODAY!

U.S. TOOL COMPANY INC. *116 Mechanic St Newark, N.J.*



Patent Applied For

The FAVORITE

A Perfected Radio Cabinet

No Aerial—No Loop—No Ground

This latest radio sensation is a complete instrument for the home, office, school, store, etc. All equipment concealed within cabinet, which can be moved about at will without affecting its operation or its clear, mellow tone.

The FAVORITE operates in all weather conditions with absolute safety, and with its loud speaker is the most perfect reproducer on the market.

Cabinet sold separately or completely equipped. Operates any good hook-up. It provides for sharp, selective tuning and clear reception. Simple in operation and perfect in results.

Beautifully finished in mahogany, walnut or oak.

Write for descriptive circular and prices.

Dealers' territory open.

Invented and Manufactured by

G. A. BARTHOLOMEW

409 Guardian Bldg. Cleveland, Ohio

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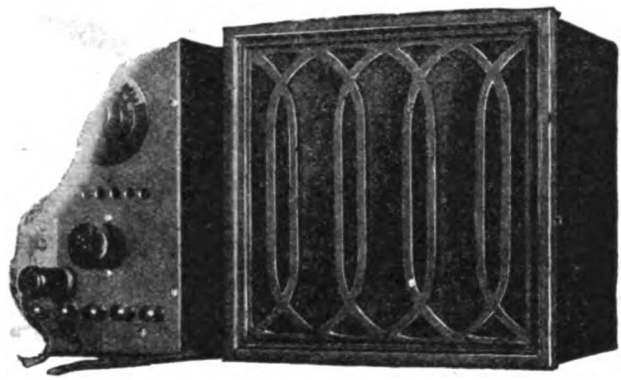
The new Timmons Talker with stationary magnet. The Gothic scroll design is the same as the adjustable type. Price $25.



The Most Beautiful Loud Speaker in the World

Just as the phonograph had to develop from its many shaped horn stage, so is radio going ahead right now.

Today the radio cabinet with its polished panel, knobs and hand stained wood, belongs in the room with the piano and phonograph; but the loud speaker—is it also at home there? Or does it appear out of place, grotesque or gawkish?

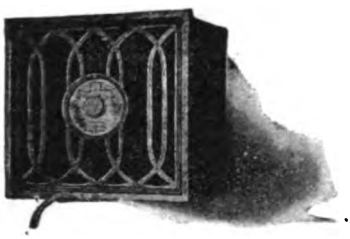
Our thought in designing Timmons talkers was to make them beautiful in appearance as well as in tone.

Both types have a finely executed grill of Gothic design. Similar to the talker cabinet, these have a rich hand-rubbed mahogany finish. Type "A" (adjustable) has a bronzed screen and dial, while the other, type "N" (non-adjustable) has a copper color screen of material similar to silk but much stronger.

Both talkers use the principle of reflected tone—that is—two horns, both, however, are hidden behind the screen. These horns are metal, one of them—the reflecting horn—is finished with "accousticoat," a substance which is built layer upon layer and makes it less liable to false vibrations and distortions than any wooden horn.

But let your dealer show you both Timmons talkers, then hear them; you will know that we actually have made Timmons talkers beautiful in tone as well as in appearance.

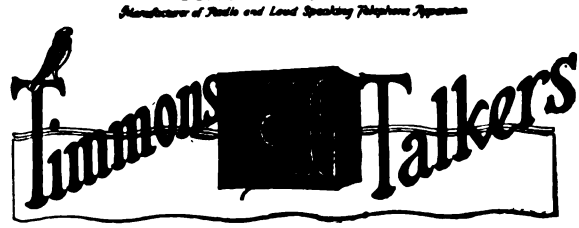
Your dealer has the new Timmons talker folder "Volume Without Noise"—or write us.



The adjustable type which now has a grill of Gothic scroll design backed by a screen of light gold color. Price $35.

Note in the illustration how the lines of Timmons Talkers are in harmony with those of all radio sets—there's no jarring conflict of shapes.

J. S. TIMMONS
339 East Tulpehocken St.
Germantown, Phila., Pa.
Manufacturer of Radio and Loud Speaking Telephone Apparatus



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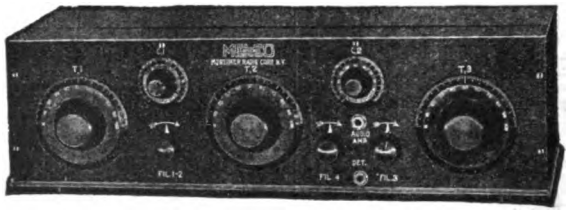
MELCO MEANS



REAL RADIO PERFORMANCE

New Principle of Tuned Radio Frequency Gives Remarkable Results

with the

MELCO-SUPREME

The Radio-Frequency Amplifying Receiver that—

Price Only $125

Operates with merely a 10 FT. WIRE—not even a ground necessary.

Offers exceptional CLARITY without the slightest loss of tone quality.

Assures unusual program SELECTIVITY through its single tuning adjustment.

Affords real LONG DISTANCE by covering all Broadcasting ranges from 180 to 610 Meters.

Complete knock-down parts for Melco-Supreme including drilled engraved Bakelite panel and solid mahogany cabinet

PRICE $75

Mr. Lawrence Cockaday in his article on Tuned Radio-Frequency Amplification in the August "POPULAR RADIO" describes in minute detail the Acmedyne Circuit as employed in the Melco-Supreme

Write for complete literature on all Amsco Parts.

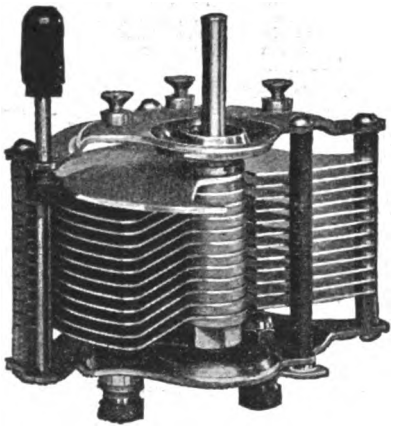
AMSCO PRODUCTS, Inc.

Broome and Lafayette Streets **Dept. P.R.** **New York City**

MIGNON NEW TYPE

STRAIGHT LINE VERNIER

AIR CONDENSERS



POINTS OF SUPERIORITY

1. Stator plates instead of being loosely fitted are pressed into slots assuring *perfect electrical contact.*
2. Proper capacities and no over-rating of same.
3. Rigid construction so original adjustment is maintained.
4. Rotor and Stator plates of logarithmic curve type.
5. Formica insulation throughout.
6. Patented vernier arrangement eliminating body capacity.
7. Accurate and correct spacing of special spring aluminum plates.
8. Lowest dielectric losses proven by laboratory tests.
9. Friction adjustment on rotor shaft, assuring positive and permanent tuning adjustment.
10. Independent vernier control. Vernier does not rotate with main rotor plates.

COMPARE PRICES AND QUALITY

Type G., 13 Pl., .0002 M. F., $2.75—Type H., 23 Pl., .0005 M. F., $3.25—Type J., 43 Pl., .001 M. F., $3.50.

These Prices Subject to Advance Nov. 1, 1923

Sold by all Leading Electrical Firms and Radio Dealers.
If not Obtainable from Your Dealer, Write us Direct.

Jobbers, Dealers and Set Manufacturers Write for Discounts.

MIGNON ELECTRIC MFG. CORP.

27-33 SOUTH WATER STREET **ROCHESTER, N. Y.**

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Silent Circuits

CLARITY of speech and music can only be accomplished thru the use of well designed RADIO PARTS. Absolutely dependable insulation is a requisite of first importance.

Radio, a science of high frequencies and electrical stresses, requires perfect insulating materials to eliminate the leaks and losses solely responsible for noisy circuits.

GENUINE BAKELITE parts insure an efficiency resulting in perfect, SILENT CIRCUITS.

TUBE SOCKETS
R730 Standard Tube Socket
R732 UV-199, C-299 Socket
Genuine Bakelite Base, furnished either in Black or Mahogany.

RHEOSTAT DIALS
R294 White Dial
R295 Black Dial
Knobs of genuine Bakelite; Black or White Face Dials.

INDUCTANCE SWITCHES
R750 White Dial
R751 Black Dial
Made of Moulded Bakelite; Beautifully designed knobs and dials.

SWITCH LEVERS
R773 1½ in. Lever
R774 1¼ in. Lever
R775 1 in. Lever
Black or Mahogany Bakelite knob; Highly polished finish.

PLAIN RHEOSTATS
R630 6.5 ohms
R632 25 ohms
R634 40 ohms
Furnished either in Black or Mahogany Bakelite.

VERNIER RHEOSTATS
R631 6.5 ohms
R633 25 ohms
Genuine Bakelite; vernier control gives micrometer adjustment of resistance.

KING QUALITY
ALL THE NAME IMPLIES
RADIO APPARATUS
Radio Apparatus Division
KING SEWING MACHINE CO., Buffalo, N.Y.

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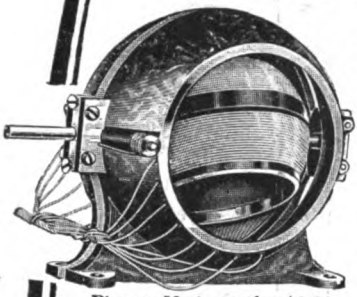
PIONEER
INSTRUMENTS

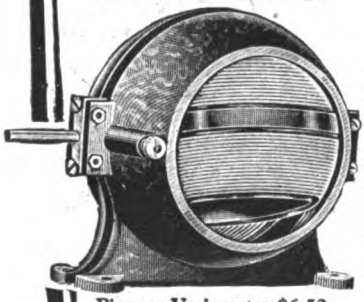


The old reliable stand-by variocoupler and variometer circuit has stood the test of time and is today in greater use than ever before.

Pioneer Variocoupler $7.00

Pioneer coupler and variometers are built to meet all the latest broadcasting wave lengths.

The variocoupler has the primary winding on the inside, giving closer inductance, and with 16 taps permits of greater selectivity and closer tuning.



The shells and rotor are of moulded Bakelite.

Moulded in our own factory under our personal supervision. All connections are positive and constant. Made for either panel or table mounting.

Pioneer Variometer $6.50

The beauty of these instruments has not yet been equalled—their electrical efficiency never surpassed. Send for illustrated folder.

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Etherphone
The SUPER SENSITIVE RADIO RECEIVER

The Perfected One-Tube Reflex

"A Milestone in Radio Progress"

Price of Instrument $45

Local Reception Through A Loud Speaker Guaranteed

This one-tube Receiver, using the UV201-A Tube, **OPERATED BY DRY CELLS,** also brings in many distant stations with sufficient volume for loud speaker reproduction. Using a head-set, one thousand mile reception has been consistently obtained under summer conditions. **COAST TO COAST RANGE PRACTICALLY ASSURED** in Winter when set is properly installed. Amplifiers may be added to the Etherphone to give loud speaker volume at all ranges.

Write for Folder, or ask your dealer

DEALERS: Write For Proposition

Radio Apparatus Co.
39 W. Milwaukee Ave., Detroit, Mich.

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A New Thrill!

Listen-In Tonight with a Kellogg Head Set

Clear reception with plenty of volume is necessary to satisfactorily hear distant stations.

Kellogg head sets should not be classed as ordinary radio receivers. Today Kellogg stands foremost in the manufacture of a high-grade head set that actually surprises listeners in comparitive tests.

Maximum volume, unusual clearness, extreme lightness in weight, are a few of the many outstanding advantages. The head band is unusually light, though durably built.

The magnets are of special tested steel and hardened by our own special method which controls the heat and time electrically and mechanically, eliminating any possible variation.

The magnet windings are of great accuracy, the mountings, end plates, wire, insulation, etc. are of the highest grade.

Our twenty-five years experience in building receivers for telephone work has proven invaluable in turning out a real radio receiver of merit.

Listen-in tonight with a pair of Kellogg receivers and get a new thrill from your radio set. With Kellogg radio equipment, USE Is The Test.

Kellogg Switchboard & Supply Company

CHICAGO

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Kellogg apparatus exclusively is used in building The Symphony Receiver

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DAY-FAN

THE DAYTON FAN & MOTOR CO.

DAYTON, OHIO, U. S. A.

Assemble Your Set With DAY-FAN Radio Apparatus

And You Will Have—

1.—Tuned Radio Frequency Amplification.
2.—A Balanced Vernier Condenser.
3.—Bankwound Bakelite Variocouplers or Variometers.
4.—High Ratio — not distorting Audio Transformers.
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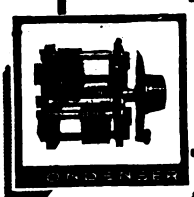
6.—A Receiving Set covering the whole public broadcasting and amateur range.
7.—The most up-to-date set in your community.
8.—Results you will be proud of.
9.—A complete layout to work from.
10.—Less money invested.



Write for booklet free of charge

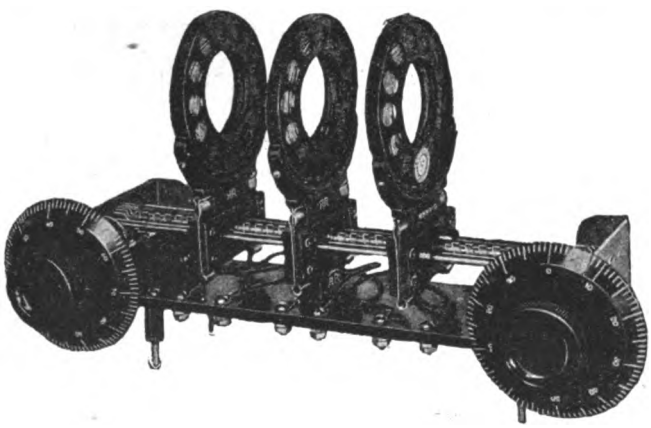
The Dayton Fan & Motor Co.

Established 1889

Dayton, Ohio

CURKOIDS

THE SUPREME INDUCTANCE



The Curkoid of a year ago was the best inductance known. We now present our improved Curkoid after months of research and test. It is wound in the same form—a Curtate Epitrochoid—but has proportions which result in 25% increased effectiveness.

Curkoids are not affected by any "exterior influence" or "body capacity" whatever. They have very low distributed capacity, high inductance, extremely low high frequency resistance—and this resistance "does not rise with the increase of frequency as rapidly as with other types of inductance" (unsolicited comment). All these make our resonance curve very acute and of greater height.

Our new model Dual and Triple No. 3 Couplers are the only accurate scientific method of coupling interchangeable inductances. They produce perfect threading of the magnetic flux fields. They have micrometer movement of 1/400 inch to one graduation on the dial.

Essentially our products are improvements that make radio worth while.

Our booklet giving tried and approved hook-ups, general authentic information, radio data, etc., Price 10c.

RIEGER RESEARCH CORPORATION

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Radio Catalogue Free—

Write us a post card—

Address Dept. 38-R

and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as $23.50.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

Headquarters for Radio

Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

Write to our house nearest you. Address Dept. 38-R

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The Oldest Mail Order House is Today the Most Progressive

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"RED-HEAD"

—*a triumph in radio receiver design*

HERE'S what we say about "Red-Heads"— they're EXTRA-ORDINARY radio receivers. We believe they're the best receivers on the market today. Superlatives are easy to say and hard to back up. Here's how we back up ours. We GUARANTEE that you'll like "Red-Heads." You take no risk in buying them. We'll refund your money plus postage if you don't agree with us after trial.

"Red-Heads" are the lowest priced, high-grade, aluminum-backed receivers on the market. Nine years of receiver experience are behind their quality.

What One User Says

The Newman-Stern Co., Waupun, Wis., July 26, 1923

Gentlemen: In 1915 I purchased a pair of your "Red-Head" phones. This pair of phones was one of the first you put out. They are still in good condition and, I believe, beat most of the other phones on the market. Very truly yours,

D. J. SAXON.

And "Red-Heads" are better today than they ever were.

READY NOW! *The New 1924 Model F—3000 Ohms*

The new Standard "Red-Heads" have ELEVEN improved features—new this year. Beautiful and graceful in appearance; light in weight; aluminum case; the famous brown-red ear caps; military headband; high-grade cord; exquisitely sensitive and fine toned. 3000 OHMS PER PAIR.

At your dealer's or prepaid on receipt of price. Per pair, Complete **$6.50**

THE NEW "RED-HEAD" JR. *2000 Ohms*

Makes its bow to the public this year in response to a demand for an extra fine 2000 Ohm phone. A remarkable production with the same workmanship and guarantee as on our standard Model F. Complete with headband and cord.

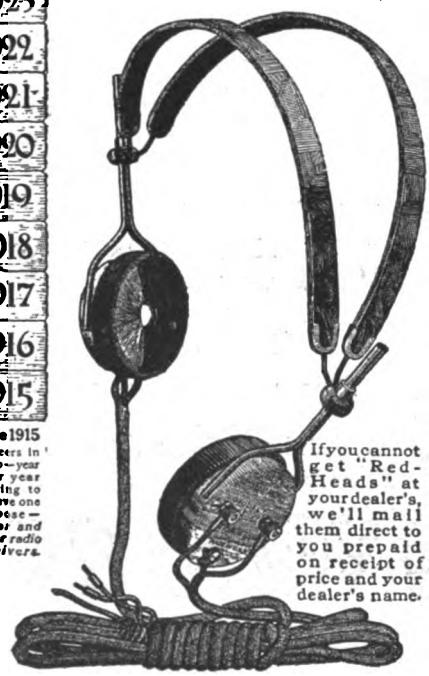
At your dealer's or prepaid on receipt of price. Per pair, Complete **$5.00**

THE GUARANTEE

Money back if after 7 days trial you're not satisfied that Red-Heads are the BEST receivers on the market at the price.

Since 1915 Pioneers in Radio—year after year striving to achieve one purpose—*better and better radio receivers.*

The Newman-Stern Co.
Dept. PR., East 12th St., Cleveland, O.



If you cannot get "Red-Heads" at your dealer's, we'll mail them direct to you prepaid on receipt of price and your dealer's name.

"Since the Dawn

of intelligence the advancement of civilization has been hand in hand with the improvements in methods of communication, until today the world may be considered to be one vast family. This is especially true in relation to the United States and Canada where the art of conveying the human voice from point to point has been developed to a very high degree."

From "The Story of Service"

Your home life and the unity of the family demand that "touch" with the outer world which Radio alone can supply. Satisfaction should be your demand in the purchase of Radio equipment. "Service" Type 212 Radio Receiver *will* give satisfaction. When you operate the set you instinctively "feel" the great distances over which you may bring desired programmes to your home.

Ask your dealer or write us.

This is a TELEFORCE product.

SERVICE RADIO COMPANY

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Dept. D.
Cincinnati, Ohio

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EISEMANN

EISEMANN Head Phones represent unexcelled value. Comparative tests prove their excellence and superior qualities. The design is simple, practical and correct.

These phones are comfortable when worn for long periods, are extraordinarily sensitive and reproduce sound with unusual clarity. Complete satisfaction is assured.

Other Radio Products:

Variometers	Variable Condensers	A. F. Amplifier units
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Complete catalogue on request

EISEMANN MAGNETO CORPORATION

William N. Shaw, *President*

BROOKLYN, N. Y.

DETROIT CHICAGO SAN FRANCISCO

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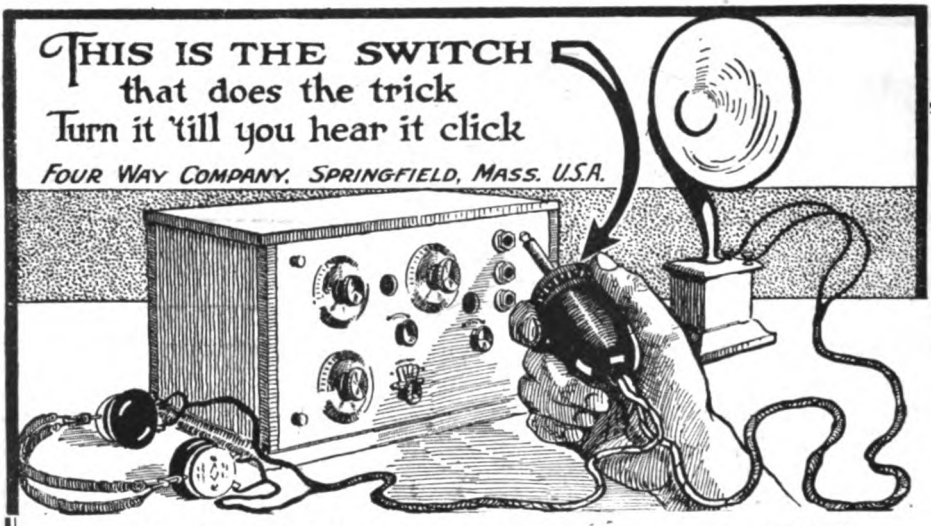
THIS IS THE SWITCH
that does the trick
Turn it 'till you hear it click

FOUR WAY COMPANY. SPRINGFIELD, MASS. U.S.A.



Turn 1: Head Set

Turn 2: Loud Speaker

Turn 3: Both in Series

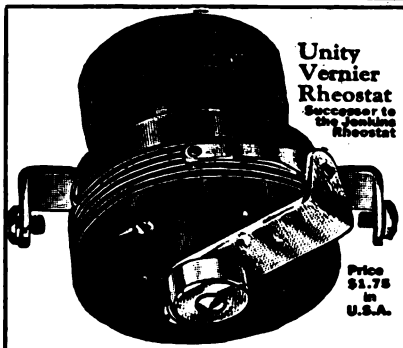
Turn 4: Both in Parallel

Here's the latest and greatest improvement in Radio!

—a switch plug which makes it possible to tune in through head set and switch in loud speaker by turning dial. Two head sets can be readily attached, or one head set and loud speaker. Both can be used at same time or either one alone. *Order yours TODAY.*

FOUR WAY CO., 29 Worthington St., Springfield, Mass.

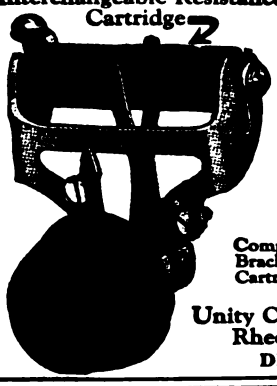
$1.50



Unity Vernier Rheostat
Successor to the Jewhina Rheostat

Price $1.75 in U.S.A.

Interchangeable Resistance Cartridge



Complete $.80
Bracket .45
Cartridge .35

Unity Cartridge Rheostat

Unlimited Adjustment

and Practical Convenience

The highest type electrical instrument for controlling resistance. A single wire followed its entire length by a contact gives noiseless adjustment and permits infinitesimal refinement in tuning. A cut-out switch turns tube on or off with absolutely no change in tuning. Made in any resistance. Stocked in 8 ohms, 20 ohms and 40 ohms. All capacities $1.75 list.

Built for Convenience

Nothing like this new Unity Cartridge Rheostat has ever been offered the radio enthusiast. Interchangeable resistance cartridge may be slipped in or out by hand in a moment's time without removing bracket or terminal. No need to buy new rheostats when you change tubes in your set. Simply pay 35c for the Unity Cartridge of the correct resistance. Made in any resistance. Stocked in 8 ohms. 20 ohms and 40 ohms. All cartridges 35c list. If your dealer cannot supply you, send money order or check and dealer's name to factory.

"Hear a set that uses one"

Unity Manufacturing Company

226 North Halstead Street, Chicago, Ill.

Automatic Screw Machine Products, Stampings—
General Manufacturing on Contract or Royalty

DEALERS: Send name and address to Factory for Free Counter Display

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S P 2

1. Unlimited range
2. Perfect reproduction
3. Simplicity of operation
4. Genuine entertainment
5. No large antenna needed
6. Beautiful workmanship
7. Factory guarantee

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W.O.R. W.H.B.
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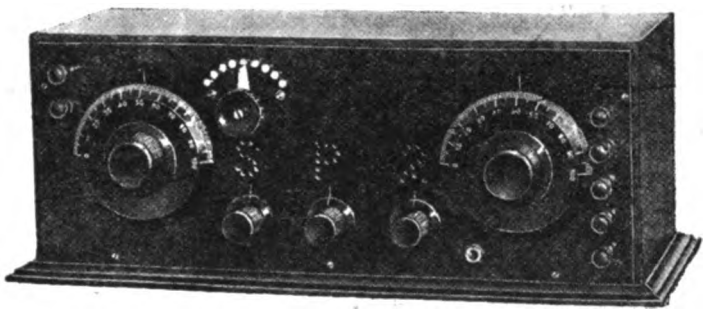
W.F.I. W.W.J.
W.D.A.R. W.L.A.G.
W.L.W. W.O.C.
W.S.B. K.S.D.
P.W.X. W.H.A.B.
W.J.A.Z. K.F.C.
K.Y.W.



THE S. P. 2 Receiver stays sold, minimizes service expenses, unlimited range offering good volume and good distance, absolutely guaranteed. What more can you ask, Mr. Radio Business Man? Your letter head brings our proposition.

Catalogue 101A:—To "Radio Fans" on receipt of 10 cents

PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Avenue **Pittsburgh, Pa.**

S P 2

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Three Aces!

IN the experience of radio engineers, amateurs and experimenters there is a suggestion which clearly points the way to the battery buyer who desires the most fitting and practical combination of electrical energy, low cost per hour of service, long shelf life and uniformity of discharge.

"ASK ANY RADIO ENGINEER"

These "Three Aces," the famous Burgess "B" —the new *double strength* Radio "A" and our latest product, the Vertical "B" Battery are playing an important part in correct and dependable reception of radio broadcast. Each is

"A Laboratory Product"

Good dealers everywhere recommend and sell Burgess Batteries

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General Sales Office: **Harris Trust Building, Chicago**
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General Offices and Works: Niagara Falls, Ontario
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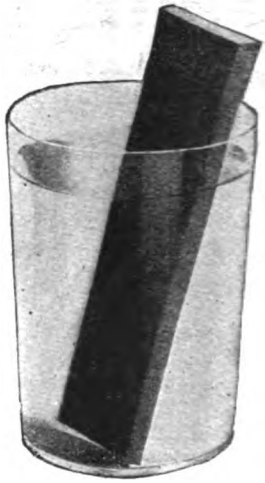
The Supreme Insulation



RADION Panels

are impervious to moisture

Moisture is a conductor of radio frequency currents. When a panel or part absorbs moisture from the air it causes short circuits between terminals. These short circuits reduce volume and frequently are the cause of distortion.

Tests have proved Radion Panels impervious to moisture. Try them and notice the difference.

Send 15c. for sample test pieces 2 x 3 inches.

18 Stock Size Panels

Radion being an insulation material especially made for wireless use, has the lowest phase angle difference, lowest dielectric constant, highest resistivity and supreme moisture, gas and acid repelling properties.

American Hard Rubber Co.
11 Mercer St., New York

RADION

Panels-Dials-Knobs-Sockets-Insulators

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FORMICA

is used in the new

FREED-EISEMANN

N R Neutrodyne Receiver*

THE panels of the new Freed-Eisemann Neutrodyne Receiver are Formica. This is natural because Freed-Eisemann have long been consistent users of Formica in all their past radio products.

It is the endorsement of leading radio concerns of this caliber from one end of the country to the other that makes Formica so staple and desirable a product for the radio dealer to handle. Amateurs know and want it.

Formica panels may be had promptly in any desired size. It isn't necessary to take a size that some one else wants to sell.

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4641 Spring Grove Ave., Cincinnati, Ohio

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FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

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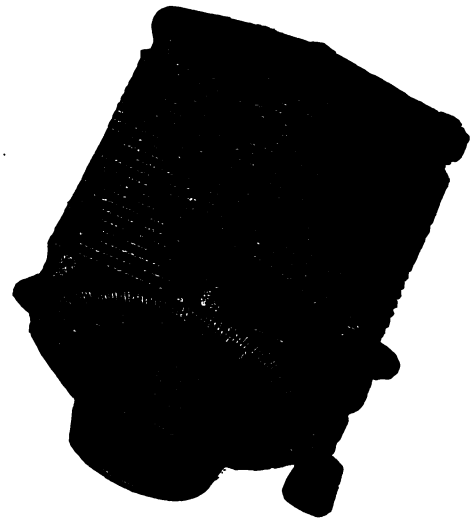
Send 50c for this FADA NEUTRODYNE BOOK

It tells in simple language how to construct a Neutrodyne circuit receiver using FADA parts. Nothing is left in doubt. Both four and five tube Neutrodyne wiring diagrams are included. In addition, in the rear of the book there are both four and five tube full size paper panel drilling templates.

This 32-page book and the use of FADA Neutrodyne and standard parts will insure successful Neutrodyne circuit receiver construction.

F. A. D. ANDREA, INC.
1581-D JEROME AVE., N. Y. C.

The special FADA Neutrodyne parts including three Neutroformers, two Neutrodons and the HOW-TO-BUILD-IT book sell for $25.00.



Radiant Condensers

Tempered Plates

THE greatest condenser trouble—*warped plates*—is made IMPOSSIBLE in *Radiant Condensers*. No more readjusting, bending and makeshift supports. Both the rotating and stationary plates are PERMANENTLY FLAT as a straight edge———. Flattened under powerful presses, and tempered by a new process, the plates of *Radiant Condensers* are unaffected by temperature changes. You can identify *Radiant Condensers* by the radiating rays design on rotary plates. *Permanent alignment is "the best condenser buy."*

Geared Vernier

Infinitely fine control of this delicate adjustment. Micrometer accuracy without special effort. Neat, smooth-working, trouble-proof gear. Another advantage for the price of just an ordinary condenser.

Write for illustrated booklet and the name of the nearest Radiant dealer.

PRICES
Vernier Type

13 Plate including 2⅛" dial and knob..... $5.00
25 Plate including 2⅛" dial and knob..... 5.50
45 Plate including 2⅛" dial and knob..... 6.50

Jobbers and Dealers Write Immediately for Proposition

HEATH RADIO & Electric Mfg. Co.

204 First Street
Newark, N. J. U. S. A.

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Magnavox Radio

Reproducers and Amplifiers

IT has been the dream of every Radio user to own in one unit a Power Amplifier and electro-dynamic Reproducer, thus insuring perfect radio reproduction. The new instruments of the unit type here illustrated in one and two stages of amplification may be had through dealers everywhere.

New Magnavox Combination Set A1-R

There is now a Magnavox for every receiving set. The full line embraces:

Magnavox Reproducers

R2 with 18-inch curvex horn . . .	$60.00
R3 with 14-inch curvex horn . . .	35.00
M1 with 14-inch curvex horn. Requires no battery for the field	35.00

Magnavox Combination Sets

A1-R consisting of electro-dynamic Reproducer with 14-inch curvex horn and 1 stage Amplifier . . .	59.00
A2-R consisting of electro-dynamic Reproducer with 14-inch curvex horn and 2 stage Amplifier . . .	85.00

Magnavox Power Amplifiers

A1—new 1-stage Power Amplifier . .	27.50
AC-2-C—2-stage Power Amplifier . .	55.00
AC-3-C—3-stage Power Amplifier . .	75.00

The new Magnavox semi-dynamic Reproducer M-1, designed for dry battery receiving sets, is also of great interest to radio users. Write for complete catalog.

THE MAGNAVOX CO., Oakland, Cal.

New York Office: 370 Seventh Avenue

PERKINS ELECTRIC CO., LTD., MONTREAL, CANADIAN DISTRIBUTORS

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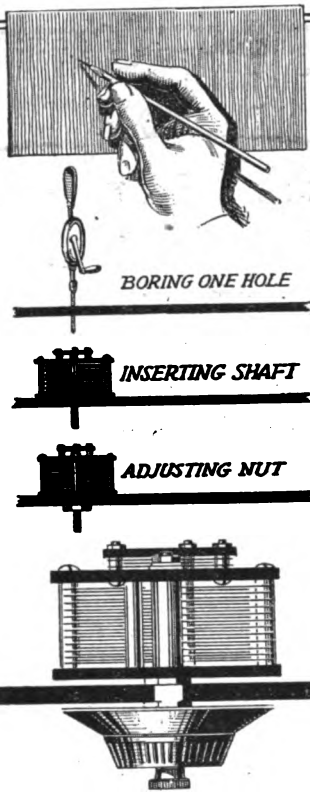

RATHBUN

SINGLE-HOLE MOUNTING

SUPERIOR CONDENSERS

QUICKER and easier to mount. No template, no danger of spoiling panels. Shafts exactly at right angles to panel so that the dial runs perfectly true. Positive contacts made SEPARATELY from vernier and rotor shafts. No current through bearings, hence no noise, no loss. The vernier turns inside the rotor shaft but is absolutely independent. These are but a few of the many points of Rathbun superiority—points of added value.

LIST PRICES—RATHBUN CONDENSERS

with Knob and Dial

11 Plate	.00025	Mfd.	$4.50
23 "	.0005	"	5.00
43 "	.001	"	6.00

Write TODAY for the name of the nearest Rathbun dealer and for illustrated literature.

RATHBUN MANUFACTURING CO.
Jamestown, New York

RHAMSTINE*

Electric Soldering Iron

For Home or Laboratory

Specially designed for radio fans and experimenters. Attractively finished in nickel; heating element Nichrome resistance wire; soldering tip, when worn can be quickly and cheaply replaced. Use with either D.C. or A.C. Guaranteed one year. And like all Rhamstine products quality is combined with low price.

$2.50

Postpaid
Complete with 6 ft. cord, two-piece plug and self-fluxing solder.

You've always wanted an electric soldering iron; you need one for radio work, and here's your opportunity to get one specially adapted to the purpose. The Rhamstine* name guarantees quality and satisfaction.

Send $2.50 and we'll send it postpaid; or if you prefer, we'll send it Parcel Post, collect.

J. THOS. RHAMSTINE,* 2162 E. Larned St., Detroit, Mich.

** Maker of Radio Products*

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"I traveled 20,000 miles in one evening!"

Mr. M. J. Doherty, of Oak Park, Ill., writes: "Many nights I hear Station KHJ (Los Angeles), CFCN (Calgary, Canada), WEAF (New York) and others as far away. In one evening I heard 30 stations, a total distance of 20,575 miles from my home."

Many wonderful and unsurpassed distance records have been made during 12 years' wide use of Tuska-made radio instruments.

Tuska Popular No. 225

3-bulb Regenerative Receiving Set. Piano finish mahogany cabinet. Amplifier switch. Concealed binding posts. Armstrong circuit, licensed under Patent No. 1,113,149. Price $75, without bulbs, batteries or loud speaker. Ask for special circular No. 15-D, describing this set.

Let the day's troubles sink with the sun

THEN turn to your Tuska Radio, and be whisked around the world. A touch of the dials, and you are in Davenport. A slight movement brings you to Philadelphia to hear the majestic music of the greatest organ. Or *anywhere* you please to go. In those precious hours between work and sleep, you live in Radio Fairyland, where you are master of distance and ruler of a host of entertainers.

Will you give your family the pleasures of Tuska Radio, which educates, soothes, amuses, and takes you traveling inexpensively? Here is the receiver that annihilates miles; bringing in music and voices sweetly, clearly and undistorted. It is the ideal set for busy people who want the thrills of radio without the tinkering.

For 12 years, Tuska Radio has been famous for advanced design and painstaking New England workmanship. The Tuska receiving set of to-day is not only up to date; it will still be serviceable in five years.

THE C. D. TUSKA CO., Hartford, Conn.

TUSKA RADIO

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Every Question ANSWERED for only $1

At last you have under one cover a Complete Radio Handbook

JUST OUT
562 PAGES

Compiled by
HARRY F. DART, B.S.E.E.

Formerly with the Western Electric Co., and U. S. Army Instructor of Radio.

Technically Edited by F. H. DOANE

NO more need you turn from book to book, hoping to find what you want. It is all here, in 562 pages crammed full of every possible radio detail. Written in plain language, by engineers for laymen. Clears up the mysteries, tells you what you want to know. A complete index puts everything within your reach in a few seconds.

IT EXPLAINS: Electrical terms and circuits, antennas, batteries, generators and motors, electron (vacuum) tubes, every receiving hook-up, radio and audio frequency amplification, broadcast and commercial transmitters and receivers, super-regeneration, codes, license rules. Many other features.

Under one cover. Yes, it is all in one volume of 562 pages of clear type with hundreds of diagrams and illustrations. Takes the place of eleven or more specialized texts, each costing from two to ten times the dollar you pay for this single book. Belongs in every radio-equipped home, on every amateur's table.

Send $1 to-day and get this 562-page I. C. S. Radio Handbook—the biggest value in radio to-day. Money back if not satisfied.

— — — — — TEAR OUT HERE — — — — —

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 8254, Scranton, Penna.

I enclose One Dollar. Please send me—postpaid—the 562-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

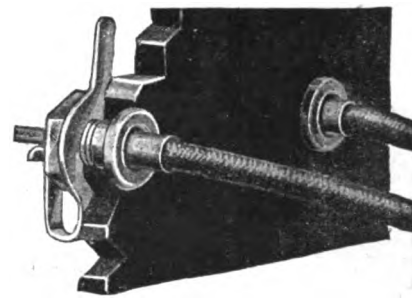
Name.....

Address.....

For All Temporary Hook-ups

UNION RADIO

TIP JACKS



Cost Only 25c a Pair

They give you quick, positive connections for all hook-ups—when you are building your own set or are experimenting with new circuits.

They can be attached to all standard thicknesses of panels. The bushing is ¼" in diameter and fits a $\frac{17}{64}$" hole. Will grip all wires from 24 B & S gauge up to antenna wire, battery leads, loading coils and vacuum tube lugs.

No parts to chip, lose or deteriorate. All parts heavily nickeled.

Other Guaranteed Parts

Dial adjusters for minute variations in capacities of variable condensers. Price 60c.

Variable Condensers. Famous for performance. Without dials, 3 Plate—$1.00; 13 Plate—$2.00; 23 Plate—$2.30.

Tube sockets of molded condensite highly polished. Phosphor Bronze contact springs. Reinforced bayonet slot prevents breakage. Accommodates all standard tubes. Price 75c.

Should your favorite Radio Store not carry Union Radio Tip Jacks and Guaranteed Parts send your order direct to us, also write for your copy of "The Union Radio Catalog A."

Retailers and Wholesalers

Samples of our guaranteed, reasonably priced "Quality Products" sent on request. Our terms and trade discounts are liberal. Write for our proposition.

UNION RADIO CORPORATION
200 MT. PLEASANT AVENUE, NEWARK, N.J.
NEW YORK OFFICE — 116 WEST 32ND STREET

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Symphony at your Fireside!

FINER music is now being broadcast. Let your whole family hear it—for both pleasure and musical education—through radio's marvelous medium, MUSIC MASTER.

Concerted band and orchestra numbers flow from MUSIC MASTER with the same clearness and fidelity of tone as the human voice or single instrument. Music at its grandest!

MUSIC MASTER is true to tone; unrivaled in clarity. It does not squawk, grate, vibrate or warp sound. Experts on acoustics, in long study, have eliminated those reproducer-faults and the result is perfection.

But hear! That is the test. Listen to MUSIC MASTER at the home of a radio-friend or at your dealer's. Let it speak for itself!

JOBBERS and DEALERS: Write for full description of the entire GERACO Line and prices.

14-inch Horn for the home **$30**

21-inch Horn for Concerts and Dancing **$35**

GENERAL RADIO CORPORATION
Makers and Distributors of High-Grade Radio Apparatus
CHICAGO PHILADELPHIA PITTSBURGH
S. W. Cor. 10th & Cherry Sts.

Music Master
RADIO REPRODUCER

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IMITATED BUT NEVER DUPLICATED

$3.50 each

This Symbol —a guarantee

Everlastingly pounding away on a quality basis has established the Shamrock trade mark as a symbol of supreme quality.

Every radio fan silently envies his friend whose critical judgment leads to the selection of Shamrock Vario-couplers and Variometers.

The particular workmanship and excellent grade of materials placed in every Shamrock product are brilliantly reflected in the superior results obtained. And results are what count.

All Shamrock instruments are made of genuine grade XX BAKELITE, are designed to positively take in all new wave lengths and incorporate all the latest features. Dealers write for trade prices.

SHAMROCK MANUFACTURING CO.
320 Market St., Newark, N. J.

SHAMROCK
FOR SELECTIVE TUNING

180° VARIO-COUPLER
VARIOMETER

DESIGNED ESPECIALLY FOR RADIO RECEIVING

We are Manufacturers of Fine Furniture and we sell direct to you with only a small factory profit.

A handsome hardwood hand-rubbed mahogany or golden oak finished Radio Table. Size of top 20 x 34 inches x 31 inches high.

Conceals A & B batteries. Small drawer holds tools and accessories.

PRICE, FREIGHT PAID, East of Mississippi River.....**$18.00**
FREIGHT PAID to Rocky Mt. States..**20.00**
FREIGHT PAID to Pacific States.....**22.50**

Cash with order. Prompt shipment.

CABINET PRICES REDUCED!

Hardwood, hand-rubbed mahogany finish. Hinged top.

Panel Size	Depth	Price
6 x 7 in.	7 in.	**$2.25**
6 x 10½ in.	7 in.	**2.50**
6 x 14 in.	7 in.	**3.00**
6 x 21 in.	10 in.	**3.75**
7 x 18 in.	10 in.	**3.50**
9 x 14 in.	10 in.	**3.50**
12 x 14 in.	10 in.	**4.00**

POSTPAID, East of Missisippi River.

POSTPAID to Rocky Mt. states, add 25 cents.

POSTPAID to Pacific states, add 50 cents.

Cash with order. Prompt shipment.

Send for free catalogue of Radio Furniture.

THE SOUTHERN TOY CO.
HICKORY, NORTH CAROLINA

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The "B" Battery is the Life of Your Radio Set

THIS IS NUMBER ONE OF A SERIES

THE only function of your Radio set is to produce sound-waves—those mechanical disturbances in the air caused by some rapidly vibrating body. So far as the Radio set itself is concerned the actual source of the sound is the "B" Battery. It is not an exaggeration to say that the "B" battery is the "life of your Radio"; for the set itself is simply a device to reproduce sounds, and the sounds all have their origin in the "B" Battery.

The "B" Battery is simply a box full of electrical energy; harnessed for you by experts. Without the Radio wave the flow of energy from the "B" battery is smooth, steady and *silent*. It is the final aim and purpose of all the many parts which go to make up a Radio receiving set, to convert the otherwise steady flow of electrical energy from the "B" Battery, into a rippling, vibrating, throbbing, audible current.

As the sound-waves—whether caused by the human voice in talking or singing, or by musical instruments—are modulated up and down—now high—now low; so does the current from the strongly vital "B" Battery follow the modulations and the variations, so that the original message, in all its delicacy of tone and vibration, comes clear and distinct through your Radio set.

Not a mere adjunct to the pleasure-giving quality of your Radio set is the "B" Battery—instead, it is the vital, life-giving part—the very heart of your Radio set.

Do not slight this vital part—give your Radio set the advantage of the best—use Eveready "B" Batteries.

Note: This is No. 1 of a series of informative advertisements which will appear in this Magazine. They are designed to help Radio users get the most out of their Batteries and Radio sets. If you have any battery problem, write to G. C. Furness, Manager Radio Division, National Carbon Co., Inc., Long Island City, N. Y.

The *New* Metal Case Eveready "B" Battery

(No. 766)

"The Life of Your Radio"

The same popular 22½ volt Eveready "B" Battery in a *new*, handsome, durable, waterproof, metal container. Eveready quality throughout. At all dealers, $3.00.

The "B" Battery is the vital part of any radio receiving set. Eveready Batteries—especially made for Radio—serve better, last longer and give better results.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, Inc.
Long Island City, N. Y.

EVEREADY
Radio Batteries
—they last longer

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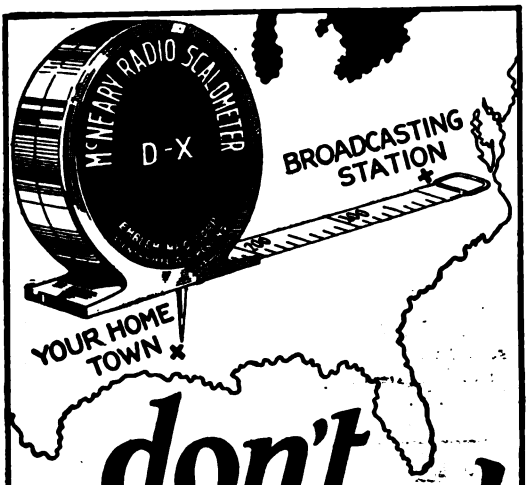

don't guess!

A SCALOMETER TELLS YOU THE CORRECT DISTANCE — *immediately!*

When that "D X" call comes in, you'll want to know the exact number of miles. No need to guess! The Scalometer tells you quickly—correctly.

With the Scalometer mounted on the official Radio Map at your receiving point—extend the tape to the broadcasting point—and you have in plain type the exact mileage.

Get the complete set—the Scalometer, the official Radio Map and comprehensive Broadcasting Directory—all for $1—at your dealers, or write us.

COMPLETE $1

EMBLEM MFG. CORPORATION
251 Middle City Bldg., Philadelphia

McNeary RADIO Scalometer
OFFICIAL RADIO MAP AND BROADCASTING DIRECTORY

Sells for $1.50

Patent Pending
Actual size

The Chelten Midget
(*VARIABLE CONDENSER*)

Is one of the newest things in Radio. It adds a Vernier feature to your ordinary condenser. But one hole to drill in your panel. Fits in a space 1⅜".

A precision instrument made to micrometer measurements. The seven stationary and six rotor plates permit of close graduation of capacity and when connected with any condenser the Chelten Midget makes possible sharper tuning and clearer signals.

Capacity .000045 Mfd. or about the same as a 3 plate condenser. The price puts it within reach of everyone.

We also manufacture a full line of High Grade Variable Condensers—Tube Sockets—Switches—Jacks—Plugs—Rheostats—Dials—Knobs—Crystal Detectors, etc.

Your Dealer Should Have These in Stock. If Not Please Write Us Direct.

Since 1910 Manufacturers of High Grade Electrical Specialties

Chelten Electric Company

4861 Stenton Avenue PHILADELPHIA

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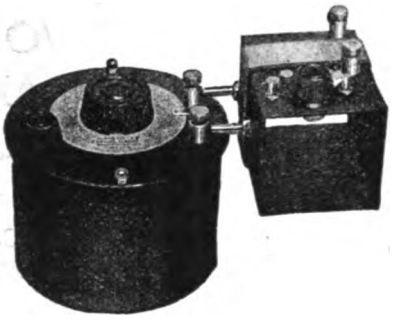
Radio Frequency Filter



Type 247W Combination Wavemeter and Filter

Have you a Broadcasting station you would like to eliminate? You can do it with our Type 247W Combination *Wavemeter* and *Filter*.

This combination, consisting of our Type 247 low loss condenser and a special coil, will enable you to cut out objectionable Broadcasting and similar annoyances. The wave length scale is read directly on the condenser dial. Range 150 to 500 meters. Simple and efficient.

Price $10.00

Send for Bulletin 916U

For those who desire a completely enclosed instrument we offer our Type 305 Filter. This instrument is similar to the Type 247W Filter in its general characteristics. It has in addition a special series-parallel selector switch enabling the filter to be used as an acceptor or rejector without changing the external connections. It is enclosed in a walnut cabinet fitted with Bakelite panel.

Type 305 Filter and Wavemeter $25.00

GENERAL RADIO COMPANY

Manufacturers of Radio and Electrical Laboratory Apparatus

Cambridge **Massachusetts**

5642

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Teleradio

Radio Engineers Know— *and buy these features*

1. A guarantee that less than five per cent variation in resistance ever exists between the coils of Teleradio head sets. The secret of accurate reproduction of faintest signals.

2. Positive adjustment of diaphragm—insures best tonal qualities.

3. Improved self adjustable friction-sleeve—positive position grip.

4. Drawn aluminum case—all metal parts highly nickel polished. Light and durable for the hardest usage.

5. Fabricated head band for unusual comfort and ease.

6. Latest engineering principles and best of materials employed in every detail of construction and manufacture.

If your dealer cannot supply you, write for catalogue and prices.

$5.50

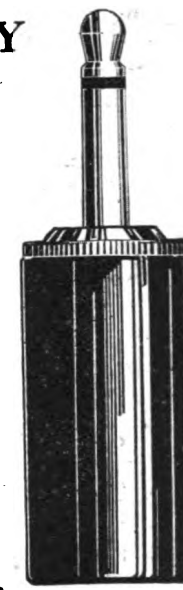
VERNIER CONDENSERS
23 plate $4.50 43 plate $5.50
VARIABLE CONDENSERS
7 plate $2.00
11 plate $2.50
23 plate $3.00
43 plate $4.00
RHEOSTATS
(Hand 30 ohm) $1.00
LIGHTNING ARRESTERS $1.00
HEAD PHONES
(2,000 ohm) $5.50
(2,200 ohm) $6.00
(3,000 ohm) $7.00

Jobbers and dealers write for trade prices

TELERADIO ENGINEERING CORP.
488-490 Broome St.
New York City

CICO

TWO WAY RADIO PLUGS



THE CICO TWO WAY PLUG is the largest selling round plug in America.

Through unprecedented quantity production, a new standard of quality value has been created.

The output of CICO PLUGS for the 1923-24 season has increased 215% over last season's figure.

Price 60 cents

No other plug made combines such sterling quality with so low a price.

Consolidated Instrument Company of America, Inc.
41 East 42nd Street
New York

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The World's Most Popular Battery Charger

Nothing speaks so eloquently of HOMCHARGER satisfaction as the fact that thru sheer merit alone it has become the *standard* by which all other battery chargers are judged. Over 125,000 HOMCHARGERS already in use offer the most convincing proof that it is the most efficient, economical and fool-proof battery charger at any price.

A NEW TRADE-MARK FOR A TRIED AND PROVEN PRODUCT

Its phenomenal success has led to the introduction of many inferior and make-shift imitations. To insure our reputation and protect the buying public against substitution, the Radio De Luxe HOMCHARGER henceforth will be sold under a new Trade-Mark, viz:

GOLD SEAL HOMCHARGER

Retaining the same fundamentally correct operating principle and beautiful appearance of our Radio De Luxe model, it is a step nearer ultimate perfection through adoption of several construction refinements dictated by the policy of Progress.

HOMCHARGER'S 10 POINTS OF SUPERIORITY

1. **Simple**—Only one moving and wearing part, replaceable after thousands of hours use for $1.00. Will last a lifetime.
2. **Efficient**—Uses less than one-half the current of any bulb or liquid type rectifier. Will charge any radio or automobile battery for a nickel.
3. **Quick**—Its high charging rate of 7 amperes eliminates long waiting for battery to become charged. Will charge any "A" or "B" battery over night, or three times as fast as a 2-ampere machine.
4. **Clean**—No expensive bulbs to break or acids to spill or replace. No acid fumes. Charges without muss, fuss or bother.
5. **Dependable**—Tungsten contacts insure continuous operation—prevent sticking and stopping.
6. **Fool-Proof**—Can be operated by anyone. Attach to lamp socket and connect battery either way, it will always charge. High-grade ammeter eliminates guess work.
7. **Safe**—No danger of shock or fire. Tested and approved by Fire Insurance Underwriters everywhere. Gives tapering charge—will not overheat or injure battery.
8. **Beautiful**—Mahogany and Gold Finish.
9. **Unqualifiedly Guaranteed.**
10. **Popularly Priced**—Retails at $18.50 complete ($22.00 Canada). No extras to buy. Sold by all dealers.

FREE BROADCASTING LIST. Send to-day for Free List of Broadcasting Stations, and Circular Describing the Gold Seal Homcharger.

DEALERS! JOBBERS!

GOLD SEAL HOMCHARGERS will outsell any other radio device this season. "GOLD SEAL Business Builders" illustrates many attractive sales helps and explains how we are prepared to co-operate with the Trade in making this a "HOMCHARGER Year." Send for your copy and Trade Discounts TODAY.

Insist on the GOLD SEAL

LOOK FOR IT

GENUINE GOLD SEAL HOMCHARGER REG. UNQUALIFIEDLY GUARANTEED

It is your protection against substitution. When buying *order by name* and *verify by the GOLD SEAL*, which appears on the carton as well as the nameplate.

The Automatic Electrical Devices Co., 132 West Third St., Cincinnati, O.

Largest Manufacturers of Vibrating Rectifiers in the World

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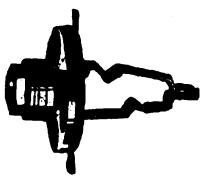
L'RADIO PARTS

Good Plugs on your Headphone and Loud Speaker cords are as important as any detail of a Receiving Set. L'Radio plugs are your best guarantee of uninterrupted service, and L'Radio Plugs are built to last. Barrel or handle removed from plug for changing cords by unscrewing lock nut from the end of the center support. Most convenient.

L'Radio Two-Phone Series Plug, No. 61, Price $1.00. Single Phone Plug, No. 60, $.90.

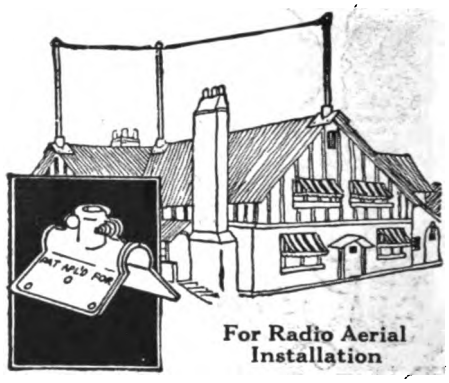
Made in single and two phone series models.

The use of Jacks in a receiving set is a convenience of great importance. At the low price of L'Radio Jacks, it is economy to use a jack wherever a detachable connection is made. The compact design of the L'Radio Jacks makes their use permissible in locations where space limitations make it impossible to use other Jacks. The connections at the panel end allows greater neatness in wiring up a new set. Buy L'Radio Parts at your dealers or write for Bulletin No. 101F.



L'-Radio Series Jack—50 Cents

LEICH ELECTRIC CO.
GENOA, ILL.
Mfrs. Non-Tune Radio Rectifiers—Leich Comfortable Head Phones.



THE BULL DOG MAST SEAT

FILLS A LONG FELT WANT by enabling anyone to install a firm and rigid mast, on either a peaked or metal ridge roll type of roof, with ordinary tools found around the home, thereby eliminating customary trouble, labor and expense. Supplying neat, substantial construction throughout the entire aerial.

Seat for 1½" mast, hinged type	$3.00
Seat for 1½" mast, peaked type, plain	2.50
Seat for 1" mast, peaked type, plain	2.00
Seat for 1½" mast, flat base	2.50

Jobbers and distributers write for discounts.

MAST SEAT MFG. CO.
119 5TH ST. S. E.
MINNEAPOLIS MINN.

Listen in with a

Dodge TONE AMPLIFIER

A scientifically perfect instrument, with wood pulp sound chamber, designed by one of the foremost acoustical specialists. This Perfect Tone

RADIO LOUD SPEAKER

insures the most delicate reproduction of voice or music and positively eliminates distortion and metallic sound.

The Dodge Tone Amplifier is enclosed in a handsome mahogany cabinet, with front panel and sound chamber finished in black. Size of complete outfit: 12 in. high, 9¾ wide, 8¼ in. deep.

The Dodge Tone Amplifier is made especially for home use, with any set of three tubes or more. No batteries necessary. No adjustments. Complete, ready for immediate use. Merely hook up and listen. Price..... $25.00

Liberal Discounts to Jobbers and Dealers

Model No. 10

ACKERMAN BROTHERS COMPANY, Inc.
Dept. "PR," 301 W. 4th Street, New York, N. Y.

Radio Veterans Demand

"Dependable"

TRIMM HEADSETS

"Professional" $7.65 **"Dependable" $5.00**

Positively the only headset on the market sold with a lifetime guarantee that covers every detail of materials and workmanship, excepting only cords and shells which cannot be guaranteed against breakage if dropped. Absolutely no charge AT ANY TIME for repairs, replacements or remagnetizing. The headsets to buy and to sell.

See! Hear! These

TRIMM LOUD TALKERS

All fitted with Special TRIMM jumbo size loud talker unit

ACOUSTICOLA	Phonograph Attachment	**$10.00**
ACOUSTICOLA	with composition horn	**22.50**
ACOUSTICOLA GRAND	with cast aluminum horn	**35.00**

Write for folder. Or order samples with privilege of return after 5 days examination and test

TRIMM RADIO MFG. CO.
Dept. 45, 24 S. Canal St., Chicago

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Na-ald Adapter No. 429
For UV-199 and C-299.
Tubes. Price 75c

It's the contact that counts

Na-ald Special
Socket No. 499
for UV—199 and
C.299 Tubes. Price 50c

De Luxe No. 400
Price 75c

A CAREFUL examination will show that each contact in Na-ald sockets and adapters is of a wiping nature on a broad surface, and so designed that strong tension is permanent, no matter how often the bulbs may be removed or how much the connecting prongs in the tubes vary.

Na-ald Sockets are moulded of Bakelite with uniform cross-section, cure and other engineering features incorporated, avoiding plate to grid losses and insuring that each tube develops its fullest efficiency.

Small Space No. 401
35c, 3 for $1.00

No. 3023—4
2 Inch
35c, 3 for $1.00

Na-ald W.D. 11 No. 411
Price 75c

The new Na-ald dials combine rare beauty of design with highest efficiency in use. These dials are moulded from genuine Condensite in such a way that absorption losses are reduced to a minimum. Knobs are so shaped that fingers do not conceal clear numerals and graduation on the bevel of Na-ald dials.

No. 3003—4
3 Inch
35c, 3 for $1.00

Na-ald Circuit Booklet packed with each Na-ald product

Write for "Why a Bakelite Socket?" and other descriptive literature

No. 450 Price 50c
Two-in-one Socket
For W.D.11 and
200 Tubes

Alden Manufacturing Company

Manufacturers of sockets and dials for every radio requirement

Dept. C **52 Willow Street**

Springfield, Mass.

Cable Address, Aldenco

No. 3783—4
3¾ Inch
Price 75c

NA-ALD

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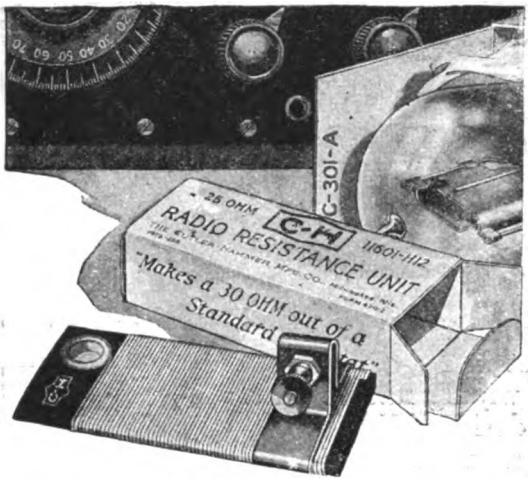


The C-H Radio Resistance Unit attaches instantly to your present rheostats for control of the "A" type tubes. Saves the cost of new rheostats, as well as the trouble of redrilling your panel. Buy one with each new tube and enjoy better reception tonight. Price 25c at dealers everywhere.

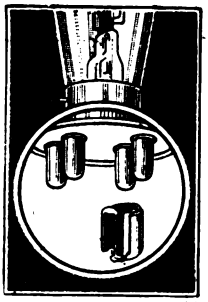
THE CUTLER-HAMMER MFG. CO.
Milwaukee, Wisconsin

C-H

More than one-half million* C-H *Radio Rheostats now in use.

CUTLER-HAMMER

PROTECT
THE HEART OF YOUR RADIO SET



Vacuum Tubes are costly and extremely delicate. B battery or any other excessive current applied for only the fraction of a second to the filament leads will burn out your tubes.

You have probably already had this experience and it is apt to happen again at any time.

A burnt-out tube means money lost—the set out of commission—inconvenience to you.

WHY TAKE THESE CHANCES WHEN RADECO SAFETY FUSES

will absolutely protect your tubes. Applied in an instant to the filament terminals. Will fit any standard tube or go in any standard socket. Fully guaranteed. **50 cts. each.** *Sent Postpaid.* Delay may be costly. Write now. Specify type of tube used.

DEPT. 2
RADIO EQUIPMENT COMPANY
630 Washington Street Boston, Mass.
New England's Oldest Exclusive Radio House
Distributors of many other successful Radio Specialties.
Dealers:— Write for our proposition and full details.

Why Put a Poor Link in a Good Chain?

The best hook-up, with the best condenser, carefully wired and with the best tubes will not give the best results without the best Transformers.

All-American
Audio Frequency
—Radio Frequency
Transformers

Radio Frequency Transformer

have been proclaimed in actual use the standard of the Radio World.

Send 2c for postage and we will send you our illustrated book of successful hook-ups.

Audio Frequency Transformer

RAULAND MFG. CO.
200 No. Jefferson St., Chicago, Ill.

DISTRIBUTORS MANUFACTURERS

The knob of the *"Ideal"* has an arrow as indicator, and the dial is made in aluminum-litho letters.

"Ideal" Rheostat and Potentiometer 100% Perfect (see illustration)

Individually packed in attractive boxes—complete with dial and knob

100 Rheostats 6 ohms **$17.50**
100 Rheostats 30 ohms **$19.50**
100 Potentiometers **$22.00**

We are making rheostats and potentiometers in composition and bakelite—the *"Marvel"* and the *"5 Star Art Works,"* switch levers, test clips, in and outside brass coil aerials, all kinds of cat whiskers, telephone brass connectors (eight to listen in) and square bus bar wire.

We sell at wholesale only.
Write at once for literature.

Base and all other parts in brass nickel plated. Resistances guaranteed 100% perfect

L&W. SPRING CO. INC.

Manufacturers
161 GRAND ST. NEW YORK CITY

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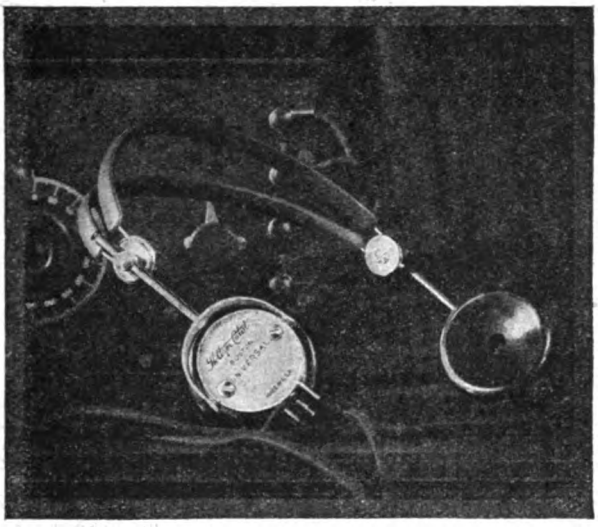

THE RADIO EXPERT KNOWS

That the varied and harmonious strains of music coming through his set—are nothing but electric current till they reach his headphones.

That the highest priced outfit is mediocre without the best headphones obtainable.

That perfect headphones preclude scientific knowledge, superior skill, and long experience in their manufacture.

That the Holtzer-Cabot Electric Company has devoted 25 years of constant research and painstaking manufacture to sensitive telephone instruments.

That the perfected Holtzer-Cabot Universal No. 2 is the ideal Headset for any radio outfit.

Holtzer-Cabot Universal No. 2, $8.50
Holtzer-Cabot National No. 4, $5.50

Be Sure to send for a copy of our booklet
"What You Should Know About Radio Reception."

THE HOLTZER-CABOT ELECTRIC CO.
125 AMORY STREET, BOSTON, MASS.
6161-65 South State Street - - Chicago, Ill.
Dept. B

Holtzer-Cabot
BUSINESS ESTABLISHED 1875

HEAD-SETS

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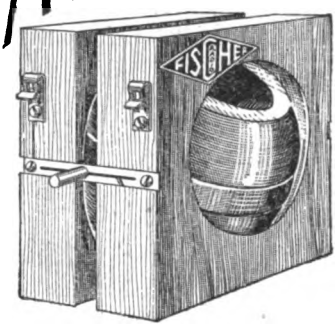
Approved!



The Champ—VARIOMETER No. 53
Approved as a Record Breaker by Wise Radio Fans Everywhere

Approved—because it makes 600 Meters.
Approved—because perfectly constructed.
Approved—because it has a genuine mahogany stator and a kiln dried rotor.
Approved—because of Fahnestock spring clip connections and non-conductive adhesive.
Approved—because—you'll know why when you

GET ONE FOR $3.50

20 Diagrams FREE with Each

For sale at your dealer's—otherwise send the $3.50 directly to the manufacturer and you will be supplied postpaid.

G. H. FISCHER & CO.
123 Liberty St. New York City

PRICE NOW
$1.00

The PACENT TWINADAPTER, MULTIJACK and DUOJACK are now $1.00 each instead of $1.50. Many more radio fans can now enjoy the convenience of these standard devices for conbination plug connections.

Don't Improvise—"PACENTIZE"

Write for descriptive Bulletins P.10

The PACENT TWINADAPTER Permits One Jack to Take Two Plugs

Pacent Electric Co., Inc.
22 Park Place, New York, N. Y.

Pacent
RADIO ESSENTIALS

Grewol
THE PERMANENT DETECTOR

The only crystal detector that has won such universal approval. Eliminates usual crystal detector difficulties. Adjusted to maximum efficiency and held there by vibration-proof base. Crystal protected from dust and moisture by glass enclosure. No complicated adjustments to get out of order. Needs no attention. Simplifies and improves the operation of your set. Fully patented. Unconditionally guaranteed. $2.00

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RANDEL WIRELESS COMPANY
4 Central Ave. Newark, N. J.

Sweeping the Nation!

1,000 MILE RECEPTION

$39 and Up

Electro Magnetic Loud-speaker
$35

Line of Remarkable Value

The Lytton line of radio masterpieces is now being demonstrated by a number of unsolicited dealers. Mark us! When our broad campaign is announced in a short time, it will start a new era in radio.

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Lytton Radio
TRADE MARK PAT. PENDING

WALTER LYTTON, INC.
CHICAGO
LYTTON BLDG.

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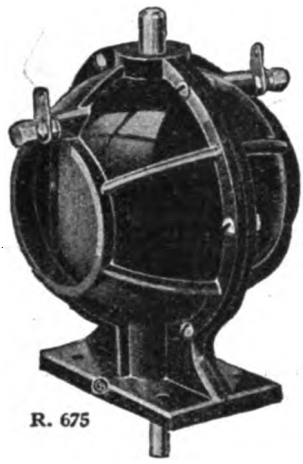
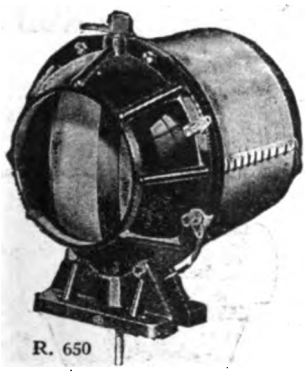


VARIOMETERS

Highest electrical efficiency. Made in 2 sizes of moulded brown bakelite, split bronze bearings. R 675 — overall height — 4⅜" Diameter of hemispherical shell 3⅜". Thickness over shell 3¾". Weight 10 oz. Wound for wave lengths approx. 150 to 500 meters. R 100—overall height 6½". Diameter of hemispherical shell 5¼". Diameter of Rotor ball 4". Wght. 1 lb. 5 oz. Wound for 150 to 700 meters approx. wave length receiving range.



VARIOCOUPLERS

None finer. Made in 2 sizes of moulded brown bakelite, split bronze bearings. Winding tapped at 15 points for very close tuning. R 650 Overall height 4⅜". Dia. of hemispherical shell 3⅜". Overall length 4½". Weight 12 oz. Wound for approx. 150 to 500 meters. R 125 overall height 6½". Dia. of hemispherical shell 5¼". Length overall —5½". Weight 1 lb. 11 oz. Wound for 150 to 700 meters approx. wave length receiving range.

Gilfillan Radio Parts

Meet Requirements

Every Gilfillan Radio part carries inbuilt to users, the assurance of *perfection* in that service detail for which it is intended.

The satisfactory operation to be obtained from any set is always limited by the *efficiency* and *dependability* of the various units contained.

Owners of sets constructed of Gilfillan Radio Parts receive that *full measure of satisfactory service* expected because Gilfillan parts are the *last word* in high quality scientific radio construction.

The experience of years gained in noteworthy manufacture of electrical apparatus is in each Gilfillan product.

Use Gilfillan Radio Parts—you'll find them reasonably priced—at leading dealers. If your dealer does not carry this line, write for names of dealers near you and price list.

GILFILLAN BROS. Inc.

1925 McGee St., Kansas City, Mo.
225 W. 57th St., New York, N. Y.
1815 W. 16th St., Los Angeles, Cal.

Licensees of General Bakelite Co.

Every genuine Gilfillan Radio Part carries this Mark—look for it—it's your SEAL OF SERVICE.

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ATWATER KENT

RADIO

3-stage Amplifier

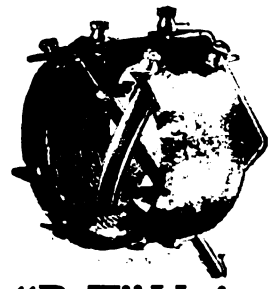
You can be sure that you will get the best results in radio performance, if it's ATWATER KENT Equipment.

Every unit is of the same accuracy—the same high quality which has characterized ATWATER KENT Products for more than 25 years.

Send for the illustrated folder

ATWATER KENT MFG. COMPANY
4933 Stenton Ave. *Radio Dept.* Philadelphia

Makers of
THE WORLD'S HIGHEST GRADE IGNITION
STARTING AND LIGHTING



The "B-T" Universal Tuning Unit

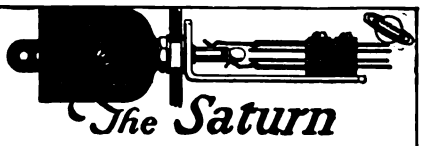
There is nothing on the market you can compare with the Bremer-Tully Universal Tuner. It is an entirely new instrument, that gives unequalled selectivity and control on practically all modern circuits.

It replaces coils in Reinartz, Ultra Audion and other regenerative and non-regenerative circuits. In most circuits taps are not required. Also gives remarkable results in Radio Frequency and all Reflex Circuits.

Simple to connect, no soldering; connections made to binding posts, easily changed to any circuit.

Photo diagrams of above, also special Bremer-Tully circuits, in addition to key of windings, furnished. Write today.

BREMER-TULLY MFG. CO.
534 So. Canal Street, Chicago, Illinois



The Saturn

"Above the Ordinary" Radio Products

Automatic Plug

Automatically perfect connection. Cord tips held in vise-like grip; instantly released by light touch on lever. Fully guaranteed.

List Price **$1**

Perfect Jack

Crowfoot offset and solder-flux compound on blades simplifies soldering. Nickle-plated brass bracket with rounded corners. German-silver blades and sterling silver contact points.

List Prices

No. 1	Single Circuit, Open	50c.
No. 2	" " closed	55c.
No. 3	Double " "	75c.
No. 4	Single Filament control	75c.
No. 5	Double " "	80c.

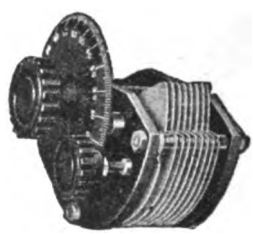
Write for Folder

The SATURN Mfg. & Sales Co.
48 Beekman St.
New York, N. Y.

RADIO A-C DAYTON PRODUCTS

Here is the Vernier Condenser that the trade has been looking for. It is a vernier that can rightfully be called a real vernier because it gives hair-splitting accuracy.

In this condenser we have actually eliminated all faults heretofore found in variable condensers. This may sound as an idle boast but all we ask is a trial for your own conviction.



There is no chance for noise because main shaft is pigtailed and vernier plate is anchored by two studs and *does not rotate.* The vernier action is obtained by a micrometer screw operating the vernier plate, changing the separation with respect to the adjacent movable plate. We claim the accuracy to be fully 300% greater than any other vernier and in addition no noise in adjusting.

The set builder demands a small condenser and here is another point in favor because this vernier condenser is no larger than a plain one. It is ideal for the new NEUTRODYNE CIRCUIT as the capacity is uniform.

We manufacture a complete line of high-grade Radio Equipment and we would be glad to send you our 1924 catalog upon request.

THE A-C ELECTRICAL MFG. CO.
Dayton, Ohio U. S. A.
Makers of Electrical Devices for over 20 years

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You Owe Your Business to the Boys

The magical growth of the radio business in America has been brought about by the boys. Over two and a half million installed and operating sets testify to the energy, ingenuity and contagious enthusiasm of boys for radio.

The appeal of radio is to the imagination of youth, and youth, inoculated, has spread the whole country with radio virus. It is the boys' dollars which have built the dealers' parts business. Boys' savings have financed uncounted complete sets. To-day boys are the recognized authorities on radio equipment, construction, installation and operation. And in a vast majority of cases the interest of fathers and older brothers in radio is due to the insistence and persistence of the boy in the family.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

goes straight to the source of radio sales. It places the radio advertiser's product before half a million up-to-date sons of well-to-do families—boys who average 15½ to 16 years old.

These AMERICAN BOY readers are radio "bugs," because the Radio Department of THE AMERICAN BOY is one of the most reliable sources of information on the subject. Its readers regularly "eat up" Armstrong Perry's instructive and authoritative articles. Your advertisement broadcasted to these keen, interested boys will find the greatest market in the world tuned in and listening eagerly.

Copy reaching us by the fifteenth of October will catch the December issue.

THE SPRAGUE PUBLISHING COMPANY
(Member A.B.C.)
548 Lafayette Boulevard, Detroit, Mich.

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Mr. Radio Dealer: Tie to a Profit Maker—the Mu-Rad

When the presidents of a score or more of Chicago's largest banks buy the Mu-Rad Receiver and write involuntary testimonials of approval, there must be a reason.

When one of Chicago's oldest and largest exclusive Radio stores sells more Mu-Rad Receivers than all other types of Receivers combined, there must be a reason.

And there is! Mu-Rad sells because to hear the Mu-Rad is to buy it. More than 80% of Mu-Rad demonstrations result in sales!

Write for Mu-Rad Franchise

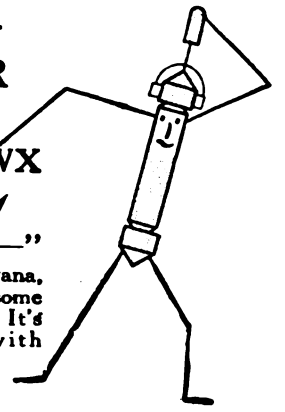
It costs you nothing to get complete details of our special Mu-Rad proposition. Just drop us a line—today—before someone else in your neghborhood gets exclusive Mu-Rad privileges.

Chicago Radio Apparatus Co.
Jobbers of Good Radio Merchandise
General Offices: 407 S. Dearborn Street, Chicago

DURHAM + DUBILIER

Tube Control

***PWX**

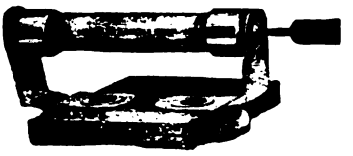


"This is Station——"

*If you get PWX—Havana, Cuba — now, pick some other distant station. It's at your finger tips with DURHAM plunger control.

DURHAM
Variables
No. 101—to 5 megs.
No. 201A—10 megs.

DUBILIER
Condensers
.00025 mfd.
.00050 mfd.



Guaranteed Satisfaction

Your dealer has it for $1.10 complete

Durham & Co., 1936 Market St., Philadelphia

Dealers:—Durham-Dubilier not only brings in many stations — but also many customers. *Sell 'em!*

Smart!

Handsomely finished a sleek, everlasting black, Bakelite-Dilecto (xx grade) makes the smartest, most "professional"-looking radio panels.

bakelite-dilecto!!

(A Laminated Phenolic Condensation Material)

It has *no* disadvantages for radio! And *every* advantage.

Strong, tough, durable; yet machinable. Warpless! Used in the U. S. Navy and Signal Corps nine years!

Get Bakelite-Dilecto cut to size. Your electrical dealer knows how.

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware
Dealer Service From:
New York, 233 Broadway
Pittsburgh, 301 Fifth Ave.
Chicago, 332 S. Michigan Ave.
San Francisco, 75 Fremont St.
Los Angeles, 411 S. Main St.
Seattle, 1041 Sixth Ave., S.

Regal Inductance Switch

15 Point Inductance Switch complete in one unit. No more drilling holes in panel. No more difficult soldering. Does away with all switch points. Beware of cheap imitations. Ask for the "REGAL." Price **$1.50**

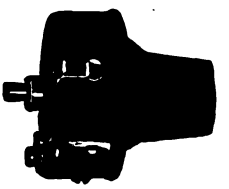
New Regal Products for the 1923-1924 Season

New Regal Audio Frequency Transformer.
New Regal Double Arm Inductance Switch.
New Regal Vernier Rheostat—30 Ohms.
New Regal Potentiometer—250 Ohms.
New Regal—Vario-Coupler.
Write for catalog No. 24.

Regal Rheostat

A high grade quality instrument. Has full exposed resistance wire giving sharp, sensitive adjustment.

6 Ohms.....	**$1.00**
30 Ohms.....	**1.00**
30 Ohms Vernier.	**1.25**



The American Specialty Co.
Bridgeport, Conn.

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Another Use For Loud Speaker

When the static is too great for radio reception your AUDIOPHONE Loud Speaker can be used with the Bristol Phonograph Record Reproducer on your phonograph. Then you may have concert or dance program without interruption.

Attached instantly without mutilating the instrument in any way—the Bristol Phonograph Record Reproducer can be used with any make of phonograph.

Equipped with such an outfit there are no disappointments—it is always ready—never fails. For dance music you have the equivalent of an orchestra, but without the expense.

The tone of the phonograph thus amplified through the AUDIOPHONE has volume enough to fill large rooms and the quality is round—smooth—and beautiful—entirely free from mechanical noises.

Remember that the same AUDIOPHONE Loud Speaker is used in common for both radio reception and phonograph record reproduction.

Write for Bulletin 3007-L and we will advise where you may hear a demonstration.

TRADE MARK
AUDIOPHONE
REG. U. S. PAT. OFFICE

THE BRISTOL COMPANY
WATERBURY, CONN.

Branch Offices:

Boston New York Pittsburgh Philadelphia
Detroit Chicago St. Louis San Francisco

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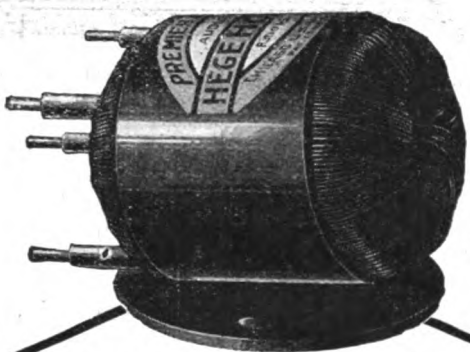


CUT EXACT SIZE
PATENT PENDING

$3.50

PREMIER

"HEGEHOG"

TRADE MARK

AUDIO FREQUENCY TRANSFORMER

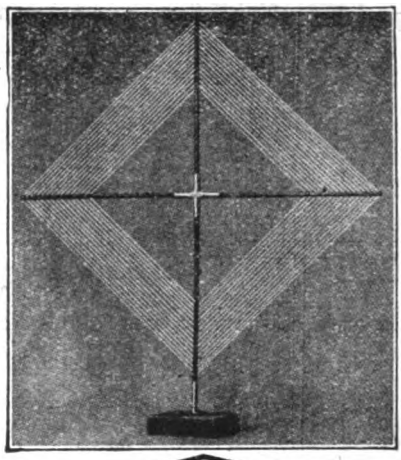
The most efficient, compact and small transformer yet designed—Truly wonderful in tone quality—It gives a maximum volume with a minimum distortion—It is 100 percent shielded and mounts anywhere—RATIOS: 1 to 3, 1 to 4 and 1 to 5—all $3.50.

ASK YOUR DEALER FOR *"HEGEHOG"*

Premier Electric Company

EST. 1905

3807 RAVENSWOOD AVE., CHICAGO



HARTMAN

LOOP AERIAL $10.00

Light—Substantial—Efficient—Directional
4 inch molded dial-detachable base.

Hartman loops stay taut and true.

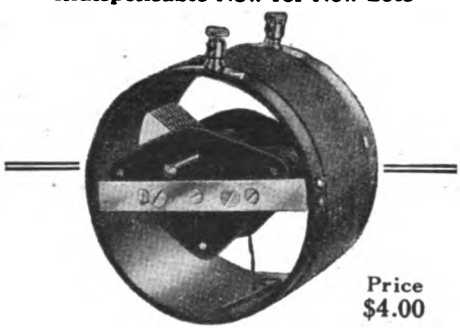
33½ in. wide—36½ in. high—15 turns—4 in. dial.

Write for bulletins on Hartman Radio parts.

THE HARTMAN ELECTRICAL MFG. CO.
Mansfield, Ohio

New Tuning Unit For the Coming Season

Indispensable Now for New Sets



Price
$4.00

HORNE VERNI-TUNER

(Trade Mark)

Primary, Secondary and Condenser.
All within a short 4 inch tube.

A GREAT SPACE SAVER

Sharper tuning than possible with any other coupling and at one-half the cost.

Used for the Main Tuning-in circuits: Regenerative, all types, Tuned Radio-Frequency, Reflex—Reinartz—Ultra Audion—Flewelling

At your dealer or postpaid on receipt of purchase price. Write for free descriptive leaflet.

HORNE ELECTRIC & MFG. CO.
Mercer and Colgate Sts. Jersey City, N. J.

"UNITED"

Radio Instruments

improve the range, clearness and tone quality of both nearby and distant broadcasting. Voluntary testimony from appreciative users all over the world leaves no doubt about this. The reasons are in the instruments themselves — their electrical correctness, and their precision workmanship, from better-than-need-be materials.

"United" Amplifying Transformer

Audio Frequency. Magnetically shielded. Scientifically insulated. Sturdily constructed. Micrometered to a 1-1000-inch exactness. Ratio 5 to 1. Handsome'y finished in nickel and black enamel. Efficiency unsurpassed. Loud, clear, no distortion. Price, postpaid **$4.50**

"United" Variable Plate Condensers

Remarkably delicate selectivity. Hard aluminum plates, held mechanically in perfect alignment, free from "shorting" troubles. 3 to 43 plate sizes, with and without Vernier Dial and Knob.

If your dealer can't supply you, remit to us and give his name and address.

UNITED MFG. & DISTRIBUTING CO.
9705 Cottage Grove Ave., Chicago, Illinois

New York Office: 50 Church Street, New York, N. Y.
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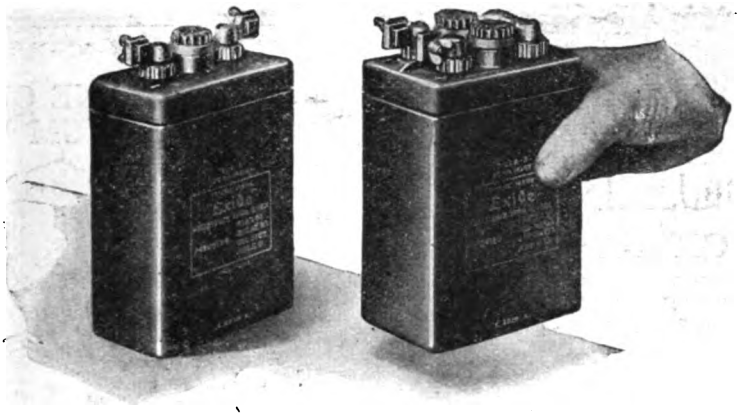


Midgets in size—but giants in power

IMAGINE a radio storage battery so light you can lift it on the palm of your hand, but powerful enough to supply all the current you need for long-distance receiving—and then some!

The new two- and four-volt Exide A Batteries for low-voltage tubes weigh only five and six pounds each. And they are wizards of efficiency—right in step with the latest developments in radio receiving.

These sturdy little batteries are neat and compact. They were specially designed for WD-11 and UV-199 vacuum tubes, but can be used with any low-voltage tube. The two-volt Exide A Battery consists of a single cell. It will heat the filament of a quarter-ampere tube for approximately 96 hours. The four-volt A Battery, having two cells, will light the filament of a 60-milliampere tube for 200 hours.

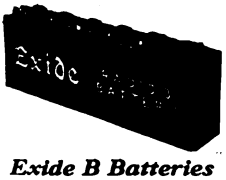
For six-volt tubes

Like all Exide Storage Batteries, the Exide A Battery for six-volt tubes is dependable and long-lasting. It is made in four sizes, of 25, 50, 100 and 150 ampere hour capacities.

As you know, any variation of current in the plate circuit produces weird sounds in your phones. With an Exide B Battery hooked up to your set, static is the only interference you will have to contend with. The Exide B Battery supplies steady, noiseless current. It permits the niceties of adjustment that make radio receiving an unalloyed pleasure. The Exide A Battery for six-volt tubes has extra-heavy plates, assuring constant potential and uniform current over a long period of discharge. Like all Exide Batteries, it embodies the finest materials available.

In marine and commercial wireless

On sea and on land the Exide plays an important role in the industrial life of the nation. In marine wireless, Exide Batteries provide an indispensable store of emergency current. A majority of all government and commercial wireless plants are equipped with Exides.



Exide B Batteries

give noiseless, full-powered service over a long period of discharge. Designed throughout to prevent electrical leakage. Capacity, 3 ampere hours.

Exide Radio Batteries are sold by radio dealers and Exide Service Stations everywhere. Ask your dealer for booklets describing in detail the complete line of Exide Radio Batteries. Or write direct to us.

Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Oldest and largest manufacturers in the world of storage batteries for every purpose

Service Stations Everywhere **Branches in Seventeen Cities**

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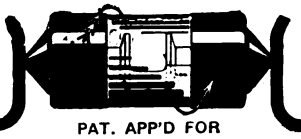


PAT. APP'D FOR

75c **TURN-IT** 75c

GRID-LEAK

"ADJUSTABLE"

Sometimes a fixed leak just happens to be satisfactory, and the right value for tube and signal, but *why fuss with fixed leaks* to find the one required when a TURN-IT adjustable grid leak has a thousand values at your demand.

The high resistance liquid with its flowing, velvety contact, gives you instantly any value necessary to develop your detector tube's maximum output.

Just clip it into your standard mount, Turn-it until that distant signal comes in clear and loud, and it will stay put. Can be conveniently rigged for panel control.

Your dealer should have one for you, if not send 75 cents to—

Charles E. Bonine

20 South 15th St. Philadelphia

for

PURE TONE QUALITY

and MAXIMUM VOLUME

Price $7
Ask your dealer.

Or, sent carriage charges collect. (Wt. 1 lb.)

The AMERTRAN

AUDIO TRANSFORMER

—recognized by the Radio Profession as the

STANDARD of EXCELLENCE

Turn ratio, 5:1. Amplification ratio, 30-40 times audibility in the flat part of the curve.

Send for Circular 1005

American Transformer Company

Designers and builders of radio transformers for over 22 years.

175 Emmet St., Newark, N. J.

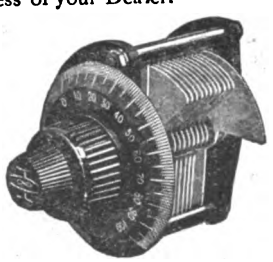
H&H **Radio Material**

Nutmeg Brand

Based on 30 Years' Manufacturing and Electrical Development-Work

We carefully fill orders direct where the goods are not sold locally, if sent along with the name and address of your Dealer.

Features of H. & H. Variable Air Condensers: Double-cone bearings with adjustment screw; smoothest possible action. Blades assembled with absolute precision; anchored solidly in large supporting posts: —proper spacing is permanent. Aluminum alloy blades; extra large brass center post; bakelite ends. The utmost in engineering skill, at prices you may well take advantage of:



W605	5-Plates, .000125 mfd	$2.50
W611	11-Plates, .00025 mfd	3.00
W623	23-Plates, .0005 mfd	3.50
W643	43-Plates, .001 mfd	4.00
W621	11-Plates with Vernier Dial Control	4.25
W633	23-Plates with Vernier Dial Control	5.00
W643	43-Plates with Vernier Dial Control	6.00

Ask for interesting circulars

THE HART & HEGEMAN MFG. CO.

HARTFORD, CONN.

3,250 Hours' Service From a $15.00 F-F BATTERY CHARGER

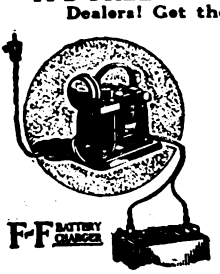
Dear Sir: Find enclosed fifty-four cents for which please send one set of carbon brushes for an F-F Battery Charger, Type 6.
This charger has been in use on an average of 25 hours a week for about two and one-half years and the Carbons have never been renewed. The machine is giving very good service.

Yours very truly,
(Signed) RALPH C. PETERS.
1810 Pine St., Boulder, Colo.

This unsolicited report is but one of thousands. It is the result of ten years specialization. You, too, can benefit just as Mr. Peters above, by insisting on the F-F Charger.

There's a type for every need. Buy from your dealer. If he cannot supply you, write for literature or enclose remittance covering express or postal charges on 9 lbs.

IT'S FREE—Write for Bulletin No. 44
Dealers! Get the F-F proposition



$15.00

F. O. B. CLEVELAND

Type 6 charges, 6 Volt Storage Battery from any 110 Volt 60 Cycle lamp socket at average rate of 6 amperes.

The France Mfg. Co.
10444 Berea Road
Cleveland, Ohio

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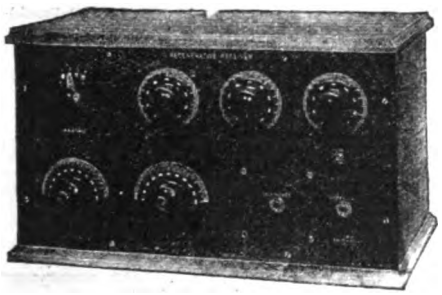
CHELSEA

LEADERSHIP THRU QUALITY AND A COMPLETE LINE

REGENERATIVE RECEIVER NO. 102



THREE TUBE RECEIVER, NO. 102
(Licensed under Armstrong U. S. Patent No. 1,113,149)

Chelsea Regenerative Receiver No. 102 is a supersensitive instrument operating on wave lengths of from 100 to over 600 meters. It combines great range and selectivity.

A Regenerative Circuit with two stages of audio frequency amplification is used. Most efficient adjustments are made possible by the use of vernier controls incorporated in the variocoupler and tuning condenser. All binding posts are enclosed in the cabinet eliminating all visible wiring. All insulating material is genuine bakelite, moulded in the Chelsea factory. The cabinet is solid mahogany, beautifully finished with space for batteries. Price $95.00. Write for Booklet A.

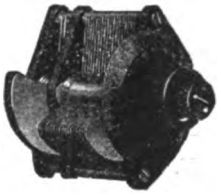
CHELSEA PARTS

The National Chelsea Radio Corporation offers a complete line of parts. These are identical with those responsible for the marvelous results obtained by Chelsea Receivers. For complete description and prices write for Booklet "B."

Variometer

The Chelsea Vernier Variometer is the last word in variometer design. It covers an extreme range from (100 to 600 meters) with the closest tuning. Genuine bakelite especially moulded by Chelsea is used throughout. It has no sliding contacts. Furnished complete with dial and vernier.

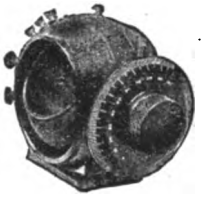
Variometer No. 80, $8.00



Variable Condensers

The Chelsea Variable Condensers contain only genuine bakelite insulating material. Rotors and Stators are die cast into solid units with perfect alignment of the plates. Spiral connections to rotors. Furnished with from 3 to 45 plates. With or without vernier. Capacities from .00025 to .001 M. F.

Prices from $2.50 to $6.75



Variocoupler

The Chelsea Variocoupler is a suitable companion piece to variometer No. 80. Its wave length range is from 100 to 600 meters. Genuine bakelite, especially moulded by Chelsea, is used throughout. No sliding contacts. All tap leads are brought to individual binding posts. Furnished complete with dial.

Variocoupler No. 90, $8.00

Write to Dept. 3 for Booklets—"A" for complete receiving sets and "B" for Parts.

NATIONAL CHELSEA RADIO CORP.
[illegible] Boylston St., [illegible], Mass.

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Learn Radio at Home

Earn $50 to $250 per week for fascinating, easy work; wonderful future in Radio. Thousands of new, big paying positions.

Easy to Learn at Home

You can easily and quickly become a "certified" *radio expert* through startling new method of National Radio Institute, one of the largest and oldest schools of radio in the world. All instruction radio instruments loaned free. Employment service free to graduates.

Send for FREE BOOK
"Your Opportunity in Radio"

Get full details of wonderful opportunities in Radio, of thousands of our successful graduates, and of remarkable, easy method of learing Radio at home to qualify for high paid positions in this tremendous new field. Mail postcard *now* for 64-page Free Book and *Special Tuition Offer* to those who enroll now.

National Radio Institute
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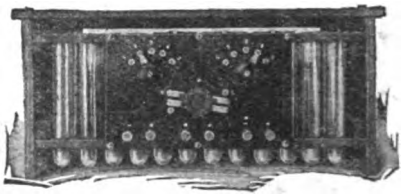
Dept. 32-J
Washington, D. C.



100 Volt Panel (new type)

KICO Storage "B" Batteries give long service at low cost

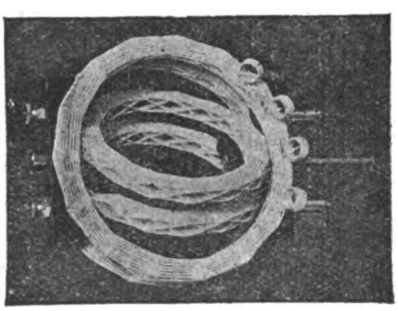
Alkaline type, will not sulphate or buckle. Life unlimited. Not harmed by short-circuiting, overcharging, or standing idle. Panel switches afford single cell variations. Easily re-charged from any 110-volt A.C. line by means of small home rectifier. One charge lasts three to six months in detector plate circuit.

Prices without rectifier:	Plain	(With Panels)
16 cell 22 volt	$5.50	
24 cell 32 volt	$7.25	$11.75
36 cell 48 volt	$9.50	$14.00
50 cell 68 volt	$12.50	$17.00
78 cell 100 volt	$17.50	$22.50
108 cell 145 volt	$23.50	$28.50
Unmounted rectifier	$1.00	
Mounted rectifier	$2.50	

SATISFACTION GUARANTEED

All batteries are sold with the privilege of receiving your money back if not satisfied within a 30 day trial. Write for full information on "A" and "B" Batteries.

KIMLEY ELECTRIC COMPANY, Inc.
2667 MAIN STREET BUFFALO, N. Y.



R. M. C. Diamond Weave Variocoupler and Variometer

Due to diamond weave construction and the fact that ⅓ of the total area of windings are supported in mid-air, capacity and dielectric losses are reduced to a minimum in R. M. C. Variometers and Variocouplers. The rotor is continuously variable.

These products may be used in any circuit where a high grade coupler or variometer is required.

All metal parts are nickel-plated. Panel mounting requires very small space. Screw holes covered by 2" dial.

R. M. C. products are built for the finest sets that can be constructed.

Variocoupler **$4.25**
Variometer **$4.25**

Write for catalog of other diamond weave coils, and Radio Frequency Transformer.

THE RADIO MANUFACTURING COMPANY
of Springfield, Massachusetts
Dept. B **97 Dwight Street**

A Better Set with A Better Aerial

WARREN RADIO LOOP

Sharper Tuning
One tuning adjustment—no others needed.

Directional
Receives signals strongest.

Selective
Picks out just the station you want to hear.

Portable
Small, light, compact. Ideal for portable and mobile sets.

Wider Range of Frequencies
on single coil.

Small re-radiative effect. Fine for regenerative circuit.

Type A-737 (300-700 meters) 6 inches square—non-directional..... **$10**
Type A-7236 (175-1000 meters) 6 inches square—non-directional..... **$12**
Type B-2537 (300-700 meters) 18 inches square—directional..... **$20**
Type BL-2520 (230-18,000 meters) with honeycomb coil mounting. 18 inches square—directional..... **$28**

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.

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Natural Re-PRODUCTION

Atlas AMPLITONE

LOUD SPEAKER

$25

Write for the Booklet "B" that PROVES.

Contains helpful information.

MIRRORS the naturalness of the original production. Actually re-PRODUCES. New principles of acoustics introduced in the marvelous "double diaphragm." Sold by all up-to-the-minute dealers.

Letters from Users Requested

"Far Superior in tone," "Surprisingly good results," "The best loud speaker before the radio public," "This most wonderful instrument"—these are typical phrases from letters written us unsolicited by enthusiastic users. What have you accomplished with your ATLAS AMPLITONE? Tell us about it!

Multiple Electric Products Co. Inc.

ORANGE ST. RADIO DIVISION NEWARK, N. J.

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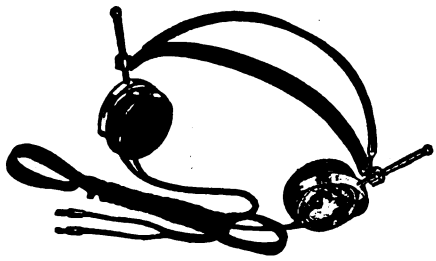
AMPL-TONE PHONES



2200 Ohms—$6.00

OUR MOTTO IS *QUALITY NOT QUANTITY*

Every precaution is used in buying materials, in assemblying parts and testing phones, assuring the purchaser of a perfect, comfortable and durable phone with a loud, clear and equalized tone.

Every phone guaranteed.

If your dealer cannot supply you, write us

C. M. FRENCH MFG. CO.

SEYMOUR, CONN.

PREMIER

MICROMETER VARIOCOUPLER

cure the new wave length trouble

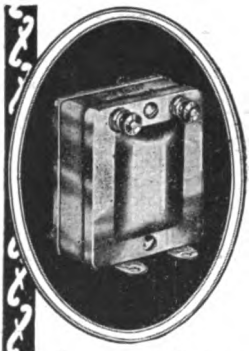
$4.50 Without Dial
$5.00 With Dial

Highly selective—180 orientation—20 antenna taps—wound with No. 21 silk covered wire—55 turns on rotor—80 turns on stator—wave range, 150 to 800 meters—positive contact—stays put any angle—Bakelite buttons on taps permit easy soldering. The coupler that really functions efficiently and will please you.

ORDER FROM YOUR DEALER

Premier Electric Company

3807 Ravenswood Ave., Chicago



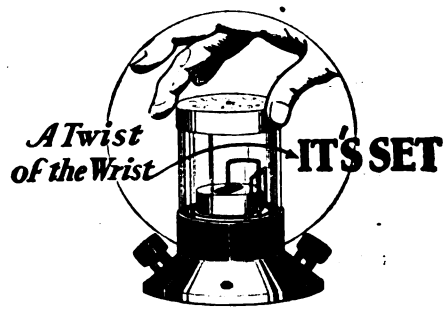
National Audio Frequency Transformers

There are many reasons why National Transformers are demanded and used by the majority of experts and amateurs—greater volume—absolutely no distortion—no interaction between fields—perfect results on any stage of amplification and with any type of tube—scientifically perfect—sturdy construction—beautiful design—highly nickel finished. If your dealer cannot supply—order direct mentioning his name. Jobbers and dealers write for sales proposition.

$4.00 postpaid

NATIONAL

NATIONAL TRANSFORMER MFG. CO.
154 Whiting St. Dept. 1011 Chicago, Ill.



YELLOWTIP

MICROMETER ADJUSTING

CRYSTAL DETECTOR

Any adjustment made in a moment—*fixed* instantly! Holds indefinitely, until you wish to change, then—"A Twist of the Wrist, It's Set." Ideal for reflex and other circuits. **$2**

Write for folder and name of your nearest dealer.

Wholesale Radio Equipment Company

Exclusive Factory Representatives

36 William Street . Newark, N. J.

Dealers and Jobbers—Write for Attractive Proposition

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Coto

"Built First to Last"

Only the Set You Build for Yourself Will Suit You

If you have just half the soul of a real radio fan, a complete, ready made set will pall on you in a week. Build your own!

You want radio performance, to be sure, but you want it of your own creation. What so fascinating as to plan, to assemble, to adjust and construct? And finally to get the radio results and the set compactness made possible by this splendid line of distinctive parts—different and better.

Coto for Efficiency and Compactness

Demand Coto—

—and Get Coto

New Coto Compact Variable Air Condenser with Vernier

Only 2⅞ inches square. Ruggedly constructed on metal frame. Rotor Plates soldered to shaft; stator plates soldered at three points. "Built First to Last." Unique, positive acting vernier. Two capacities—.0005, $5.00; .001, $6.00.

Jobbers! Dealers!

The Coto line, also including Honeycomb Coils, Cotogrip Sockets, and Coto Special Audio Frequency Transformer ($2.50) has the efficiency, the appearance and the advertising for big selling. Write today for latest price lists.

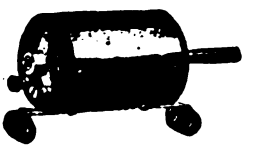
Coto Coil Co.

Providence, Rhode Island

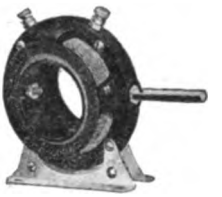
Pacific Coast Branch,
329 Union League Bldg.,
Los Angeles, Cal.

Northwestern Branch,
Geo. F. Darling,
705 Plymouth Bldg.,
Minneapolis, Minn.

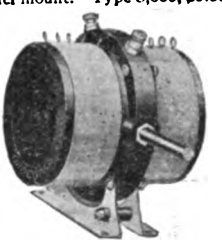
Southeastern Branch,
C. P. Atkinson,
Atlanta Trust Co. Bldg.,
Atlanta, Ga.



Radio Frequency Transformer
Efficiently covers the whole broadcasting range because it is TAPPED. Just turn the switch. Type 5,000 A, $7.50.



New Coto Compact Variometer
A little gem in moulded bakelite. Stator is honeycomb wound. Range 200 to 600 meters. Size 3½ x 1¾ x 3¾ inches. Base or panel mount. Type 8,000, $5.00.



New Coto Compact Variocoupler
Twin sister of the Variometer. Size only 3¼ x 3 x 3¾ inches. Range 200 to 600 meters. Base or panel mount. Type 9,000, $5.50.

Audio Frequency Transformer
Compact and efficient. Handles large volume with uniform amplification and minimum distortion. Approved shell type. Ratio 5 to 1. Type 4,000, $5.00.

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Build Your Own HAZELTINE NEUTRODYNE

with

FREED-EISEMANN

Licensed Essential Parts

Complete wiring diagram, instructions, etc., sent in special container with patented essential parts. Three NEUTROFORMER COILS mounted on variable condensers, and DOUBLE NEUTRODON (as illustrated) sent for $24.00. Ask your dealer to show you these parts, as well as complete assembled five-tube Neutrodyne Set in mahogany cabinet, Model NR-5, $150.

Or send 25c for Neutrodyne Constructor which shows "How to Make the Neutrodyne"

FREED-EISEMANN RADIO CORPORATION

255 Fourth Avenue New York

Licensed by I. R. M. Inc. Under Hazeltine Patents

For Long Distance Reception ATHERTON

AUDIO-FREQUENCY TRANSFORMERS

Rank Absolutely Supreme

Powerful Amplification

Clear and Perfect Reproduction on All Wave Lengths

No Distortion nor Howling

No Resonant Peak

Designed to Meet the Characteristics of All Tubes

The Highest Grade Amplifying Transformer Manufactured

Unrestrictedly Guaranteed

RATIO 5 to 1 Recommended for 1st Stage.

RATIO 3.75 to 1 Recommended for 2nd Stage and All Stages Thereafter

List Price, **$6.50** All Ratios.

Sold by all high grade radio dealers, or mailed postpaid direct upon receipt of price.

Dealers and Jobbers Write for Attractive Discounts.

WOLVERINE MANUFACTURING COMPANY

603 East Water Street

Milwaukee, Wisconsin, U. S. A.

FERBEND

TRADE Wave Trap MARK

PATENT APPLIED FOR

The *Original* Wave Filter

Stops Interference!

Eliminates interfering stations.
Improves the selectivity of the set.
Eliminates local broadcasting.
Selects between conflicting stations.
Simplifies tuning.
Often increases signal strength.
Reduces howling and squealing.

The WAVE TRAP is mounted on a Formica panel in a beautiful mahogany finished cabinet 6x5x6, and is a high-grade instrument throughout enhancing the appearance of the most expensive sets.

$8.50 CHARGES PREPAID

Ferbend Electric Co.

21 E. SOUTH WATER ST.

CHICAGO

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We Offer Cash for Your Spare Time

MAIL the little coupon today. It will mean money to you.

For every subscription to POPULAR RADIO, that you send us, we will reward you liberally in cash commissions and bonuses.

Many of your friends and acquaintances will be glad to subscribe to POPULAR RADIO when they learn that the price is going up and that they can save a dollar by subscribing now, through you.

Mail the coupon for full particulars and a sample copy.

POPULAR RADIO, Dept. 108
9 East 40th Street, New York City

Please tell me how I can make money in my spare time taking subscriptions to POPULAR RADIO. Send along a sample copy for me to work with; also other necessary supplies.

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England

AMPLION

Canada

Scotland

Australia

Wales

New Zealand

Ireland

So. Africa

WITH the Amplion Loud Speaker the infinite clearness and softness of tone achieves an unsurpassed reproduction welcomed and admired everywhere. The human voice or musical sounds come to you in their true richness, without the slightest distortion, unalloyed —just as they are rendered.

It is hard to believe you are listening to reproduction. Originality is so unmistakably registered in every tone.

The Amplion is made by the world's oldest manufacturer of loud speaking instruments. It is not a head set receiver used as a loud speaker, but a development for radio purposes of a loud speaking device, used exclusively on every ship of the British and other leading navies.

The Amplion requires no battery. You simply attach it in place of head phones. The Amplion is being extensively used in every country mentioned in the border of this announcement.

That it has been adopted as standard by the leading countries of the world is the tribute it has achieved through its brilliant performance.

All models on view at the New York Radio Exposition, Booth 5, at the New York Show—Oct. 6th to 13th.

SIGNAL ELECTRIC MFG. CO.
Sole United States Distributors Menominee, Michigan

BURNDEPT OF CANADA, LTD.
Canadian Distributors 172 King St., West, Toronto

Norway

India

Sweden

France

Denmark

Italy

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Spain

The Supremacy of the AMPLION is the Supremacy of Actual Performance

Belgium

Japan

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Paderewski Knows Quality

From ALL OTHER Amplifying Devices PADEREWSKI Selected

THE ACOUSTICAL AMPLIFIER
BEL-CANTO
• TRADE • MARK •

For Its PURITY OF TONE AND PERFECT REPRODUCTION

Thousands of Highly Satisfied Owners Applaud His Choice

24" High
10" Bell
Crystalline
Finish
List
$22.50
F.O.B.
Factory

FOUR REASONS WHY

1. Large Heavy Base Eliminates Top Heaviness.
2. Combination Rattan Reed and Fiber Strengthens Horn and Gives Beautiful Quality Without Distortion.
3. No Adjustment Necessary; Will Work Perfectly on Any Good Two Stage Set.
4. Guaranteed Against Mechanical Defects of any Kind for One Year.

THESE ARE EXCLUSIVE BEL-CANTO FEATURES

Write for Territory and Discounts

Bel-Canto Mfg. Co.
417 EAST 34th STREET
NEW YORK CITY

INSTRUMENT MAKERS

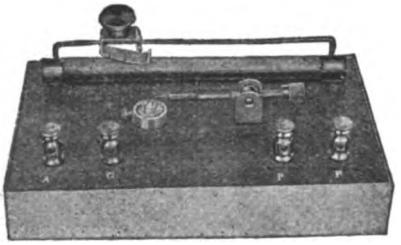
DEPENDABLE TESCO PRODUCTS

SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



FREE FAMOUS TESCO RADIO Crystal Set (Shown in Cut)

To introduce the wonderful T-B-H radio headset we will give absolutely free of charge, the most efficient crystal receiver on the market.

SEND NO MONEY

Just pay postman $5.00 plus postage. Money refunded if not absolutely satisfied.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.

Just Out!

Special Reprints of the Cockaday "DX" and 4-Circuit Tuners

THE tremendous demand for copies of January and May POPULAR RADIO has completely exhausted our supply. These are the issues in which were described and illustrated Mr. Cockaday's famous "DX" Regenerative Receiver, and the 4-Circuit Tuner.

Every day brings more requests for these popular issues. So in order to satisfy the demand, we have had special Reprints made of these two articles, just as they appeared in the January and May issues of POPULAR RADIO.

Each of these 12-page Reprints contains complete working details—photographs, diagrams and instructions on how to build, assemble and operate these famous Receivers. A full list of the parts required is also given, with their approximate total cost. Nothing has been omitted.

And to bring down the cost of these Reprints to the same price as the magazine itself, they have been priced at the moderate figure of *only 22 cents each* (postage included).

If you are one of the many who have been unable to secure copies of these missing issues, this announcement will bring you welcome news. Or if you have already built *one* or *both* of these famous sets, the convenient and compact size of these Reprints make them very handy to keep permanently with your receiving set.

POPULAR RADIO, Dept. 100
9 East 40th Street, New York City

Please send me the following special Reprint of Mr. Cockaday's article describing his

☐ **"DX" Regenerative Receiver** (reprinted from POPULAR RADIO for January)

☐ **4-Circuit Tuner** (reprinted from POPULAR RADIO for May)

I enclose..... cents in stamps (22 cents each, including postage).

Name.....

Address.....

City.....State.....

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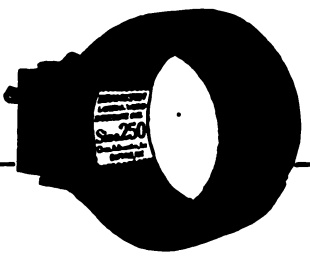
Branston D. L. Honeycomb Coils and Mountings



R-61 Three Coil Geared Type. Front panel mounting. **$5.00**

Substantial gears give vernier adjustment. Very neat appearance. Made of Genuine Bakelite, complete with flexible leads.

R-73 Three Coil Bakelite Mounting. **$4.50**

Neatest three coil mounting on the market. Made of Genuine Bakelite and complete with flexible leads.

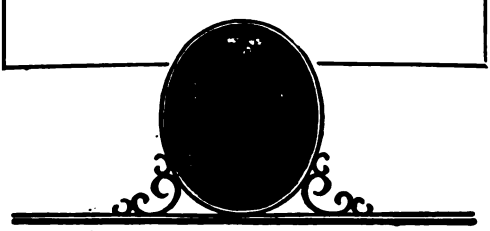
R-77 Bakelite Coil Mounting with brackets instead of screws for mounting. **50c**

STUDY these mountings carefully. Our new No. R61 3-coil front panel mounting and No. R62 rear panel mounting are equipped with strong brass nickel plated gears, insuring smooth vernier adjustment with no chance of stripping gears. Back geared type is equipped with arrow knobs that show position of coils. Mountings are substantially constructed of genuine Bakelite and are equipped with flexible leads.

Branston D. L. Honeycomb coils are accepted as standard in regard to superior construction and electrical unit of mountings. Your dealer can purchase Branston Coils and Mountings from his distributor. Insist on the Genuine.

Send 2c in stamps for Series 1 "Hook-Up" circulars showing five good Honeycomb Coil Hook-Ups and Catalog of famous Branston Radio Apparatus. Write today. Give us name of your radio dealer. If he can't supply you, write

Chas. A. Branston, Inc.
811 Main St., Buffalo, N. Y.
In Canada: Chas A. Branston, Ltd., Toronto, Ont.

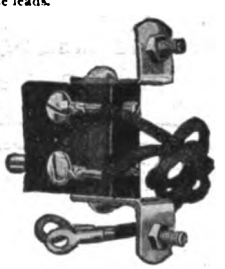


R-62 Three Coil Bevel Geared type. Back Panel Mountings. **$6.00**

Bevel gears provide very smooth operation and vernier adjustment. Made of Genuine Bakelite, complete with flexible leads. Arrow knobs show position of coils.

R-71 Two-coil Mounting. **$3.25**

Very neat and capable of smooth operation. Only two mounting screws required. Complete with flexible leads.



R-68 Single movable Bakelite Plug with extension angle brackets and flexible leads. **90c**

R-69—Same as No. R-68 only stationary. 90c

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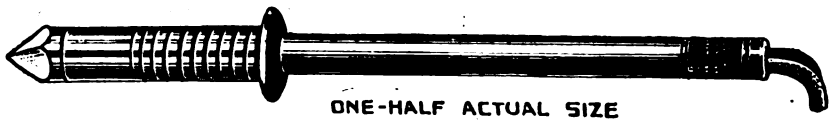
METALECTRIC SOLDERING IRON

(The All-Metal Instrument)

"A solution to the small soldering problems of the discriminating assembler"

Inter-changeable tip



$5.50

ONE-HALF ACTUAL SIZE

Unbreakable Construction—Economical Operation on any Electric Circuit

from your dealer or write

POST ELECTRIC CO., Mf'rs. (Instruments Division) 30 East 42nd St., N. Y. C.

ORDER BY MAIL

Something New

Radio Condenser Plate Cleaner

Chemically treated to prevent lint. Removes accumulations between plates. Eliminates noises, clears reception. Restores pep to your set.

You cannot afford to be without one.

Price **15 cents** prepaid. Do not send stamps.

This is only one of the many up to the minute Radio parts from our Catalogue. Send for our Catalogue No. 10.

ATWOOD ELECTRIC CO.

3122 W. Madison St., Dept. R Chicago, Ill

Dealers write!

ACMEDYNE TELOS

Vario-formers

are the only practical devices for obtaining tuned radio frequency amplification in one unit. Vario-formers can be used in any capacity neutralized circuit. Type TC4 for wave length range of 180 to 610 meters.

Manufactured exclusively by

DANZIGER-JONES, Inc.

145A Prince St. New York City

MPM MILLION POINT MINERAL

THE WORLD'S GREATEST RADIO CRYSTAL

REFLEX SUPERIORITY! RESULTS GUARANTEED!

Are you getting the best from your Reflex Set?

M. P. M. (MILLION POINT MINERAL) CRYSTAL

—tested and guaranteed—has proven itself the superior crystal for Reflex Reception. M. P. M. will not corrode or burn out; does not lose its sensitiveness; and clear, musical, economical reproduction is assured. Unsolicited testimonials show marvelous long-distance records, both with and without amplification. Ask your dealer for M. P. M., or send us 50 cents for two unmounted, or 70 cents for two mounted; and, in addition to crystals, we will send you diagram of a reflex circuit that we guarantee will give absolute satisfaction.

M. P. M. SALES CO., Dept. PR, 247 So. Central Ave., Los Angeles, Cal.

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On the Wings of the Air

NORTH, South, East, West, over mountain ranges, across rivers and ravines, through storms and clear weather fly the magic voices of radio. Throughout the country a multitude of eager listeners, old and young, settle down to enjoy the entertainments. Hundreds of stations are broadcasting every evening. There is always something going on to please every listener.

PARAGON

Reg. U.S. Pat. Off.

RADIO PRODUCTS

With the Paragon Three-Circuit Receiver you can pick the program you want to hear, tune in on the station that is broadcasting it, and ***you will get it.*** The messages will be understandable, the music clear and harmonious. In fact, you will first realize the full enjoyments of radio the first time you listen in with a Paragon set.

An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN CO., 20 Alvin Ave., Upper Montclair, N. J.

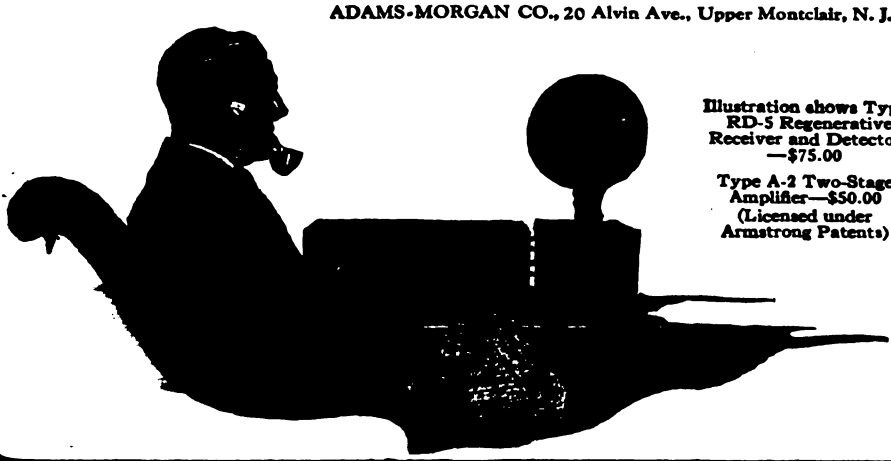

Illustration shows Type RD-5 Regenerative Receiver and Detector —$75.00

Type A-2 Two-Stage Amplifier—$50.00 (Licensed under Armstrong Patents)

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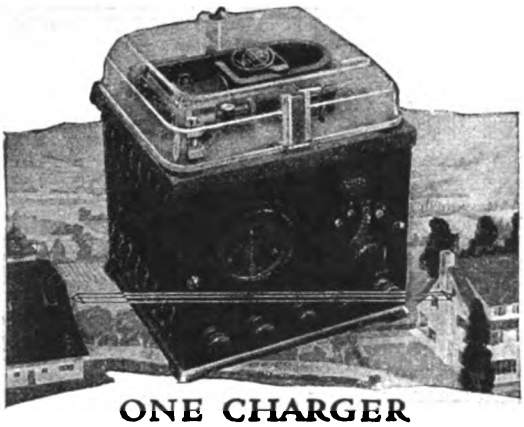


ONE CHARGER
for Every Radio Battery

—And, in fact, *the only one* which you need. Keeps strong clear signals in your set by keeping the batteries to full capacity.

The Valley Type ABC Battery Charger is made for all storage batteries—2-volt peanut tube batteries, 6-volt A Batteries and 1 to 4 B Batteries. Bakelite panel, glass top —belongs to a radio receiving set.

Frankly, production is limited. Late buyers are going to be disappointed. A lot were last year. Ask to see the Valley Type ABC Charger at any good radio shop.

VALLEY ELECTRIC CO.
3157 S. Kingshighway St. Louis, Mo.

Valley Battery Charger

The Condenser Sensation of Modern Radio

FRESHMAN
NOISELESS
TESTED MICA
CONDENSER
MFG. BY
CHAS. FRESHMAN CO. Inc.
NEW YORK CITY

Through the accuracy and dependability of Freshman Condensers, hook-ups and circuits have been perfected which have completely revolutionized the art of Radio Reception.

These little Storers of energy and rectifiers of Radio Current are the very heart of a well-built radio set.

The proper fixed condenser will make all the difference in the world in the reception, clarity and selectivity your set affords.

Capacity	Each	Capacity	Each
.0001	$ .35	.002	$ .40
.00015	.35	.0025	.50
.00025	.35	.003	.60
.0002	.35	.004	.75
.0003	.35	.005	.75
.00035	.35	.006	.75
.0005	.35	.008	1.00
.0006	.40	.01	1.00
.0008	.40	.015	1.50
.001	.40	.02	2.00
.0015	.40	.025	2.50

The FRESHMAN is so designed that constant equal pressure is exerted on the condenser plates over the entire area. They are the only condensers that do this and therefore the only condensers that avoid noises, which are due to variable pressure on the plates.

At your dealers, otherwise send purchase price and you will be supplied without further charge.

Chas. Freshman Co. Inc.
Radio Condenser Products
106 SEVENTH AVE., NEW YORK

$3.50 THE RITTER GRAND CRYSTAL SET $3.50

Has proven to be the survival of the fittest. The reasons are:-

1. Dependability
2. Simplicity of operation
3. Low Popular Price

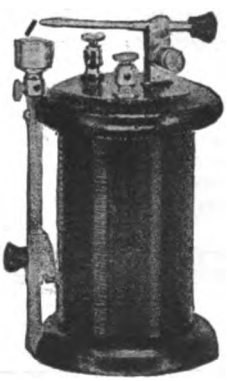
Sold at all stores or direct.

We are the originators of the famous

$1.00 Ritter Portable Loop $1.00

The only knockdown Loop Aerial sold. We supply complete instructions with every outfit.
Our guarantee: The Ritter Portable Loop will give as good results as any $10.00 Loop.
By mail 10 cents extra.

Agents and dealers write for our proposition.



RITTER RADIO CORPORATION
232 Canal St. New York City

TYPE AI
$25.00
21" Fibre Horn

The TRINITY LOUD SPEAKER

The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

For sale by good dealers. Literature upon request.

TRINITY RADIO CORPORATION
446½ Tremont Street, Boston, Mass.

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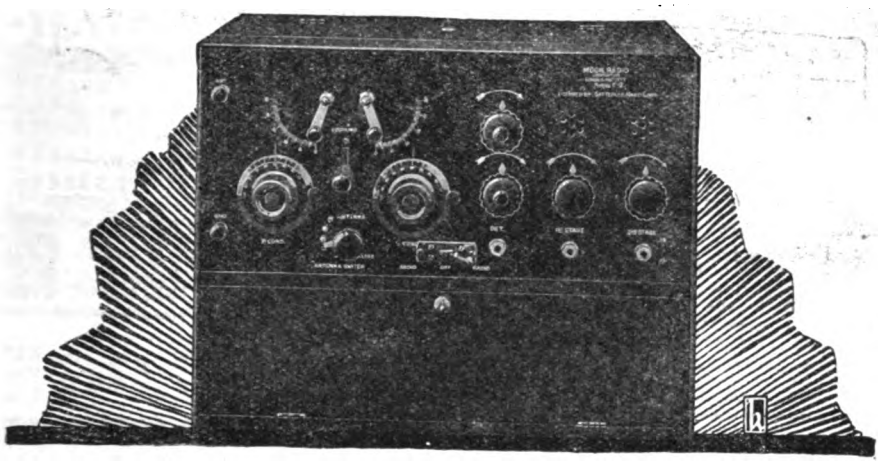

The Apex of Achievement

Our New Factory

Progressive growth of any organization obviously deserves a just reward and we are not an exception. Proudly pointing, through rapid expansion and the overcoming of almost unsurmountable obstacles, to the acquiring and immediate occupancy of our new three story building at 501 Steinway Ave., Long Island City, N. Y.

Moving into new quarters produced an invigorating abundance of initiative and efficiency. Undisputable evidence of sane progress and instant service.

THE Moon Radio Corporation offers to the public a set that operates on very different principles from any other set on the market. By means of a single connection, broadcasted programs are now received through the land, sea or air.

It is the result of the synthetic evolution of a well defined theory of "Inductive Amplification" which adds to the embryonic receiver another revolutionary advancement in the development of antennaless reception, by the use of a "Terrapoise," "Aquapoise" or an "Aeropoise."

The development of a perfect radio receiver that would operate under this system was made possible through intensive research and exhaustive experimentation by its inventor, Dr. Francis LeRoy Satterlee, with the co-operation and assistance of an able staff and the Executive Departments of the Moon Radio Corporation.

The **Moon C-2 Receiver** will span the Continent from North to South or from East to West. And no matter where you are, at home, at the camp, in your motorboat or on a railway train, reception will be maintained with loud speaker volume of perfect quality, for a conservative thousand mile range.

The **C-2 Receiver** costs $157.50. At your dealer. Or send us his name and ask for literature.

MOON RADIO CORPORATION

Manufacturers of "Satterlee" and Antennaless Receiving Sets.

502 Steinway Ave. Long Island City, N. Y.

MOON C-2 RECEIVER

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The latest and most essential part of an efficient tube set

Variable Resistance Leaks

FOR PANEL MOUNTING

Mounted on any panel in a few seconds—
2 screws serving as connections behind panel.
When mounted only the knob shows on the panel.

Get stations you never heard before

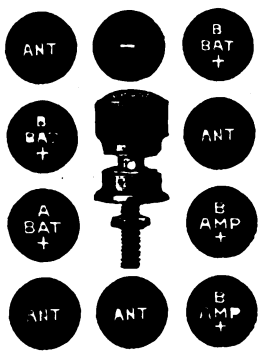
No pencil markings. Assure unbroken range of 180 degrees.
Clarify signals—eliminate hissing.

Complete with either .00025 or .0005 mfd. Mica Condenser..... $1.00

Without Condenser.....75c

At your dealers—otherwise send purchase price and you will be supplied without further charge

Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Avenue, New York



EBY ENGRAVED POSTS

Have non-removable tops

They'll look classy on your set because the engraving will match your dials.

For sale by Dealers everywhere

The H. H. Eby Manufacturing Co.
Philadelphia, Pa.

POSITIVE RESULTS

are being obtained by thousands of satisfied users of the

EASTERN COIL SETS
for the
COCKADAY CIRCUIT

The remarkable features which are making this circuit (4 circuit tuner) more popular each day are its simplicity of construction and control—wonderful selectivity—distance records—clearness and loudness of reception, and the fact that all capacity squealing, interference, etc., are eliminated.

Made as per specifications of Mr. Cockaday, using No. 18 wire with D coil bank-wound.

COMPLETE ASSEMBLED SET OF B, C AND D COILS—PRICE..... $2.75

Hook-up directions and material list free.

Mail Orders Filled. Dealers Communicate

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Here's your opportunity. Radio needs you. Win success in this fascinating field. Trained men in demand at highest salaries. Learn at home, in your spare time.

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I will train you, quickly and easily, to design, construct, install, operate, repair, maintain, and sell all forms of Radio apparatus. My new methods are the most successful in existence. Learn to earn

$1,800 to $10,000 a Year

FREE Wonderful, home-construction, tube receiving set, of latest design. Write for **"Radio Facts"** free. Engineer Mohaupt.

American Electrical Association
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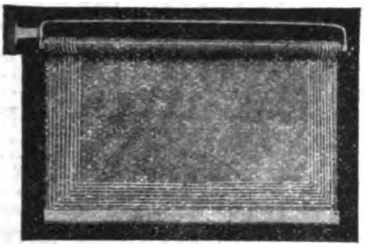
Pathé

A New Pathé Product

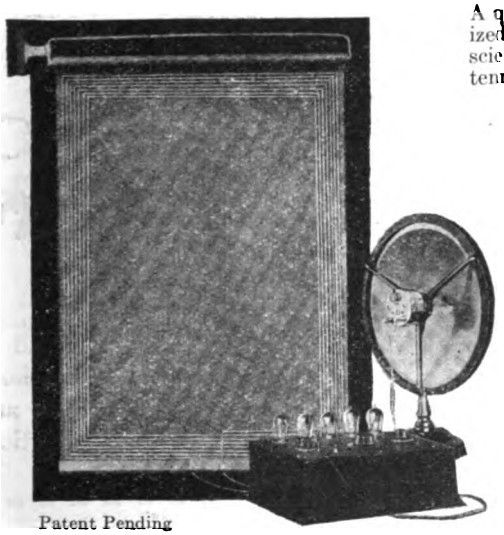
CURTANTENNA

The Only Variable Loop

Showing Collapsibility and Portability of Curtantenna



Showing How Curtantenna Can Be Varied In Size



Patent Pending

Showing Curtantenna Fully Extended in Conjunction with Set and Pathé Loud Speaker

A REVOLUTIONARY development in radio aerials for indoor use.

When fully opened is one of the largest and most efficient loops for broadcast reception.

Is instantly collapsible without kinking or tangling the wire.

Ideal for sharp tuning—unsurpassed for distance—reduces static to a minimum. Particularly effective in large cities where several stations are broadcasting at same time. Gives a degree of selectivity hitherto unobtainable.

When closed is as portable as a walking stick.

Comes with wall bracket and swivel or may be attached to any door in house.

Positive in results—very attractive in appearance—easy to handle.

Size can be varied at will.

Over 1500 miles have been covered by users of the CURTANTENNA.

A quarter of a century of highly specialized experience in the manufacture of scientific devices is behind the Curtantenna.

Price $8.50

On sale at leading radio stores. If your dealer has neglected to stock the Curtantenna, send remittance direct and shipment will be made, charges prepaid, immediately.

Other Pathé products such as the famous Pathé Loud Speaker, Pathé Dials and Pathé Variometers and Variocouplers have already established themselves as standards among users of the best radio material.

Catalogue of Pathé radio products, together with a detailed wiring diagram of a loop receiving set which covered 1500 miles using a CURTANTENNA, will be mailed on receipt of 4 cents postage. Address Dept. 197

PATHÉ PHONOGRAPH & RADIO CORPORATION

20 GRAND AVE., BROOKLYN, N. Y.

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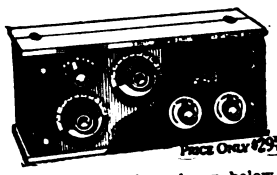


MIRACO GETS EM 1500 MILES AWAY

PRICE ONLY $29.50

At the low prices shown below you get the efficiency of sets costing three times as much.
These radio frequency receivers—pick up stations over 1,500 miles away under good conditions—everywhere.
Operate either on DRY CELLS or storage battery.
Cabinets of solid mahogany and workmanship the finest throughout. Order direct or send for bulletin.
Two tube outfit, as shown above, for use with headphones only..... $29.50
Four tube outfit for loudspeaker or headphones... $54.50

DEALERS—write for proposition quickly—it's a winner.
AGENTS

THE MIDWEST RADIO COMPANY
812 Main Street Cincinnati, Ohio

RUSONITE

CRYSTAL RECTIFIER
(Patent Pending)
THE PERFECT SYNTHETIC CRYSTAL DETECTOR
SENSITIVE OVER ENTIRE SURFACE
No Hunting for "Spots." Loud and Clear. Endorsed by Thousands of Satisfied Users
Sensitiveness Guaranteed — Price Mounted — 50c

14 K. Gold Supersensitive
RUSONITE CATWHISKER, Price 25c
Permanent. Will not Oxidize

RUSONITE REFLEX CRYSTAL
Manufactured Expressly for Reflex Circuits. Will Stand Up Under Heavy Plate Voltage
Guaranteed — Price Mounted — $1.00

Order from your dealer or direct from
RUSONITE PRODUCTS CORP.
15 Park Row New York, N. Y.

A New Simore "Lightning Change" Tool for Radio operators and fans.

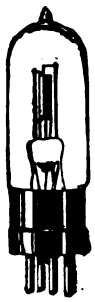
The ideal combination screw driver and knife, the knife blade can never fold or collapse and injure the operator.

Two screw driver blades, one knife blade, you select and produce the blade desired by gravity action. A turn of the thumb locks the blade for use. No loose blades—no lost blades, change blades in two seconds. Once Radio men use it for building and keeping up their sets, they won't be without it.

Only $2.25. Send money order or personal check. Makes a wonderful gift.

THE SIMON & SKIDMORE MFG. CO.
Dept. 710, Santa Ana, Calif.

Dealers and others invited to write for our proposition on this and other Simore tools.



WE REPAIR
The Following
RADIO TUBES

WD-11	$3.50	UV-199	$3.50
WD-12	3.50	C-299	3.50
UV-200	2.50	UV-201A	3.75
UV-201	3.00	C-301A	3.75
C-300	2.50	UV-202	4.00
C-301	3.00	C-302	4.00
DV-6	3.00	DV-6A	3.75

Mail orders solicited and promptly attended to.
Dealers and Agents Write for Special Discount.

H. & H. RADIO COMPANY
Clinton Hill Sta. P. O. Box 22-E. Newark, N. J.

SPECIAL OFFER

Two new yearly subscriptions to POPULAR RADIO for only .... $3.

Rope this Special Offer! It means a big saving to you. You and a friend of yours may have POPULAR RADIO for a whole year, provided you are both NEW subscribers. Just throw a check for $3 around the double coupon and MAIL IT TO-DAY before the price goes up to $3 for only *one* year's subscription!

(*Coupon good only until October 15th, 1923*)

POPULAR RADIO, Dept. 104,
9 East 40th Street, New York City
Please send POPULAR RADIO for one year to:

NAME.....

ADDRESS.....

CITY.....STATE.....

And also to this other new subscriber. Here's my cash remittance—(or a check or money order for $3).

NAME.....

ADDRESS.....

CITY.....STATE.....

(*No extra for Canada. Foreign countries 25 cents extra per subscription.*)

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RADIO FREQUENCY LABORATORIES, Inc.

announce the development of the

BALLANTINE VARIOTRANSFORMER

(Model 5)

For either panel or base mounting

At dealers or sent postpaid Price $9.60

The new R. F. Transformer that is Variable thruout range of 170-550 meters

For the keen amateur and the appreciative broadcast fan, the coming season will be marked by an increased use of radio frequency amplification. And the fixed coil type of transformer—with satisfactory amplification inherently limited to one or two very narrow resonance peaks—will of necessity give place to an instrument better suited for the newly extended schedule of wave lengths. Such an instrument is presented in the BALLANTINE VARIOTRANSFORMER—the only transformer having both primary and secondary windings *continuously variable* to give consistently high amplification at all wave lengths.

"R.F. Amplification with the Ballantine Variotransformer," 25 pages of theory and practice sent free on request.

BOONTON RUBBER MFG. CO.
224 Fanny Road
Boonton, N. J., U.S.A.

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Last Chance to Get Your Favorite Magazines at Lowest Bargain Prices!

Enter your subscription to POPULAR RADIO *now* and take advantage of these special money-saving clubs before the offer is withdrawn.

UP to October 29th only, we offer our friends and subscribers this broad selection of leading magazines at very special bargain prices with a year's subscription to POPULAR RADIO.

If you are already a subscriber to POPULAR RADIO, these special club offers allow you the privilege of renewing or extending your subscription at a **great saving of money.** If you are not already a subscriber, don't delay taking advantage of this opportunity to get POPULAR RADIO and *your choice* of these other leading magazines at *greatly reduced prices.*

As already announced, the subscription price of POPULAR RADIO will soon be advanced from $2 to $3 a year. Yet all of these magazine combinations are figured at a price for *each* magazine **far lower than even the present subscription prices.**

There is hardly a home where one of these magazines does not already bring pleasure and profit to *some* member of the household. The magazine requirements of your whole family for the coming year can be taken care of *now*, by simply checking the club offer you want and mailing the coupon to us with your remittance before October 29th.

But do not delay. Our special arrangement with these other publishers is for a few weeks only. After October 29th the prices on these clubs must be advanced. But by acting *now* you safeguard yourself, and in addition, you get POPULAR RADIO at even less than the **present** subscription price, which will soon go up to $3 instead of $2 as at present.

McCall's **Popular Radio** $3.60 Newsstand Value For..... **$2.25**	**Modern Priscilla** **Popular Radio** $4.80 Value For..... **$3.00**
Today's Housewife **Popular Radio** $3.60 Value For..... **$2.25**	**People's Home Journal** **Popular Radio** $4.20 Value For..... **$2.50**
McClure's **Popular Radio** $5.40 Value For..... **$3.75**	**Christian Herald** (52 issues) **Popular Radio** $5.00 Value For..... **$3.00**
Youth's Companion (52 issues) **Popular Radio** $5.00 Value For..... **$3.75**	**Boy's Life** **Popular Radio** $4.80 Value For..... **$3.50**
Scientific American **Popular Radio** $6.60 Value For..... **$4.75**	**Collier's** (52 issues) **Popular Radio** $5.00 Value For..... **$3.75**
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Or You Can Make Up Your Own Club of POPULAR RADIO With:

Boy's Magazine	$3.60 val., for...	$2.60
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Radio	5.40 val., for...	4.00
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Radio Digest (52 issues)	7.60 val., for...	6.25
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Review of Reviews	6.60 val., for...	4.75
World's Work	6.60 val., for...	5.00

Note: If you wish TWO or more of these magazines with POPULAR RADIO, simply deduct $1.75 from the club price quoted, then add POPULAR RADIO at $1.75. For example:

Radio (San Francisco) $4.00 less $1.75=	$2.25
Review of Reviews... 4.75 less 1.75=	3.00
POPULAR RADIO, at only	1.75
Remit this amount	**$7.00**

POPULAR RADIO, Dept. 101,
9 East 40th Street, New York City.

Enclosed is $..... Please see that yearly subscriptions are at once entered in my name for each of the magazines I have checked in the special bargain club list at the right.

Name.....

Street and Number.....

City.....State.....

(If not a NEW subscription, please mark R after the name of the magazine, to indicate RENEWAL.)

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MAKES YOUR

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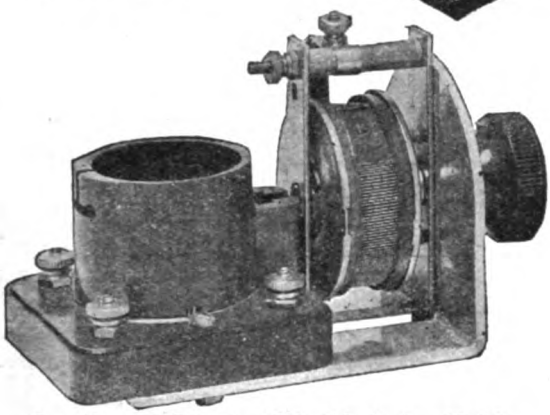
MOUNTING EASY



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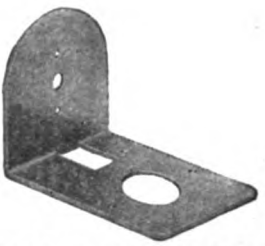

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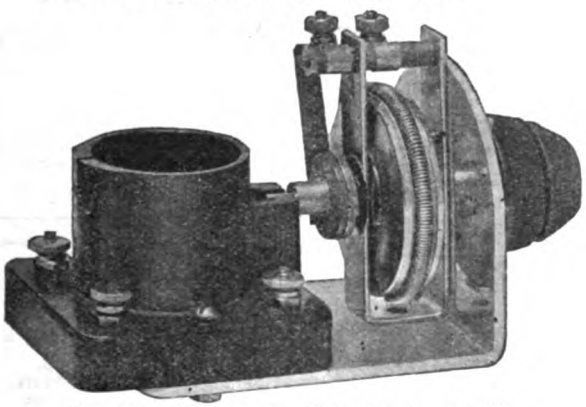

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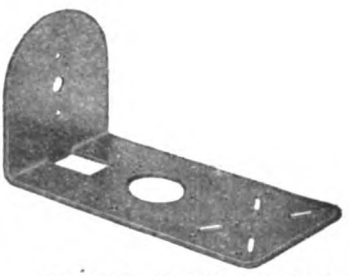

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in New York who would buy whatever radio equipment you needed from the smallest part to the complete set either assembled or unassembled—who would personally test each article you desired—who would gladly and freely advise you when you needed help—who was not interested in any radio manufacturer—who carried out your instructions to the letter and did it promptly, prepaying all shipping charges—and at prices less than if you did your own buying—he would be a *real friend* indeed! Well, here he is—write at once and get acquainted with the friendly service and money-saving story of the Personal Service Purchasing Bureau, Dept. 12, 506 Fifth Ave., New York City.

RADIO WORLD

Great National Illustrated Weekly; 15c copy. All newsdealers. Trial sub. $1.00 seven issues.

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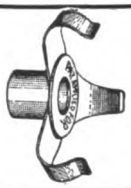

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Does not disturb the adjustment of your telephone receiver.
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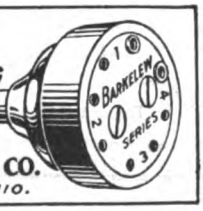

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Send stamps for large price list.

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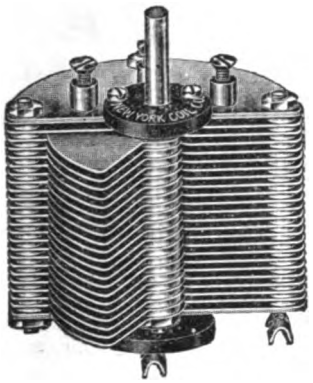
Are leaders everywhere due to quality, ease of installing and assurance that your set will bring in the results when finished. Used by leading constructors and handled by the best informed dealers.



New York Condensers bring in the broadcasting loud, and clear with the true tone, because the construction eliminates all leakage and electrical losses—the standard by which others are judged.

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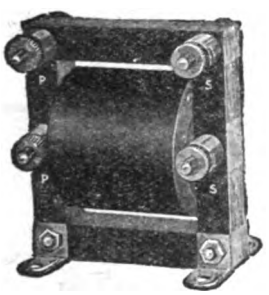
Supplementary Vernier Condenser $1.00

Insist on New York Amplifying Transformers. Do not be satisfied with something claimed to be "just as good." They are universally recognized for their marvelous amplification, purity of tone and ability to produce uniformly perfect results with any style of standard tube. Price $4.00 and worth it.



Our skeleton type tuned Radio Frequency Transformers really give the D X results with loop or indoor aerial that you have long wished for. Totally unlike any other in design or results. Two required, fully guaranteed.

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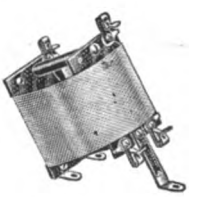

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A Bigger, *Better* "Popular Radio" for Our Friends and Subscribers

—yet it will come to you without extra cost if you act at once!

TO our big family of POPULAR RADIO readers the addition of 56 more pages of reading matter in the November issue will be mighty welcome news.

For several months past, a great store of timely and interesting articles have been piling up on the Editor's desk. There wasn't sufficient space to run them all—practical hints for the radio amateur; helpful suggestions on how to get the most out of *all types of sets;* understandable articles by distinguished scientists written exclusively for POPULAR RADIO; questions, answers; hook-ups that work; thrilling stories and personal experiences filled with romance and adventure—just the kind of "live stuff" that has made this magazine so popular with our half a million enthusiastic readers.

So there is only one thing to do. We must increase the thickness of the magazine! Now there will be no space limitations to prevent getting these articles quickly to our readers. "Month by month POPULAR RADIO is growing bigger and bigger."

The Same POPULAR RADIO *—only more of it!*

You'll be tickled with POPULAR RADIO these coming months. The same helpful, practical, interesting articles will continue. There will be more of them. New departments will be added. Don't take a chance on missing any of these bigger, better issues. Become a regular subscriber and get the magazine each month at your home.

Although the price of POPULAR RADIO will soon advance to 25 cents on the newsstands and $3 a year, you can still get a full year's subscription, 12 issues, for only $2.00. But this offer is open for a short time only. Act at once!

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If you act at once you may subscribe at the present $2.00 rate. **Or better still, you can get two years of POPULAR RADIO for only $3.00.** This is a special offer that we are extending for 30 days so our old friends and subscribers can take advantage of it. It means a saving to you of $3.00 over what two years of POPULAR RADIO will be at the new price! Just exactly **half** of what you will pay a few weeks from now!

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Do not delay filling out the attached coupon and mailing it today. A subscription to POPULAR RADIO, besides keeping you in touch with all the rapid developments in this fascinating field, will save you many times its cost in the construction and improvement of a set of your own, and will safeguard you against many an hour wasted in costly experiment.

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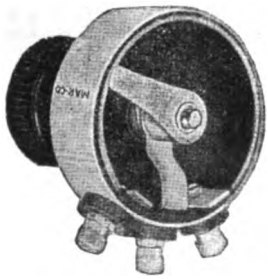

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Cannot Damage them

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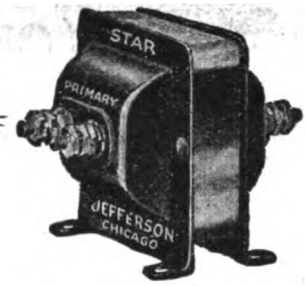

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Amplifying Transformers

have gained an enviable reputation for audibility and amplifying power. In tens of thousands of receiving sets they are insuring 100% amplification—increased range, super-sensitivity, and the elimination of howling and distortion.

This positive preference rests on the unmistakable superiorities of design and operation which make Jefferson Amplifiers the choice of discriminating radioists.

FIVE JEFFERSON TYPES

The five Jefferson types meet the demand for an audio-frequency transformer for every requirement. In this assortment you are sure to find the transformer which will make your set super-sensitive, and enable you to tune in distant stations with ease, and freedom from distortion.

Radio Bulletin Sent Free

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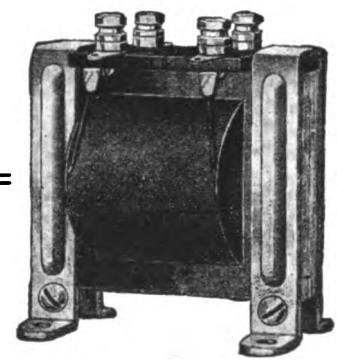

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Hundreds of reliable hook-ups and circuit diagrams—practical hints and handy knacks—money-saving tips and pointers on how to make and improve your own sets. Take your pick of all this authoritative information on radio!

PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

There are still a few copies left of each of these back issues — with the exception of January and May, 1923. *While they last* you can take your pick of them at only 22 cents each, to cover cost and mailing. Here's your opportunity to complete your files of POPULAR RADIO and to add to your store of information on just the subjects which interest you.

Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

May, 1922

—Harnessing waves to wire.
—How to make and install your own Receiving Set.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How to use your Radio Set in summer.
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.
—How to use your Phonograph as a loud speaker.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—Radio on your pleasure boat.
—How to make a variable condenser.
—The foolish fear of lightning.

September, 1922

—How to build the Armstrong Circuit Receiver.
—How the Vacuum Tube works.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How the crystal detector detects.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—Right and wrong ways of adjusting the Regenerative Receiver.
—How to make a novel variocoupler.

December, 1922

—Radio on your motor car.
—How to select the best coil for your set.
—How to make and use a loading coil.
—How the Vacuum Tube detects.
—A Receiving Set that takes notes.
—How to make a series-antenna condenser.

January, 1923 (Out of stock)

February, 1923

—20 tips on tuning.
—The Hoffman measurement charts.
—Shall I use a "hard" or "soft" tube?
—A novel tuner for shutting out interference.
—How the Audio-frequency amplifier works.
—Pointers on aerials.
—How to add an Audio-frequency amplifier.

March, 1923

—A Receiver without batteries.
—How to get the greatest efficiency out of your Radio circuits.
—How to make a one or two-step Audio-frequency Amplifier.
—How to make a Multi-Layer Coil.

April, 1923

—Regeneration without Radiation.
—A crystal detector from a spool.
—How the Vacuum Tube detects and rectifies.
—How to make a simple single tube Receiving Set.
—Circuit diagram of the Cockaday DX-3 Circuit Tuner, with instructions on how to add three stages of radio frequency.

May, 1923 (Out of stock)

June, 1923

—How to use your Radio Set on your vacation.
—How the microphone transmitter works
—How to build a good single tube receiver.
—How to make a crystal detector stand.

July, 1923

—How to install your Radio Set on your boat.
—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923

—How to build a Tuned Radio Frequency Receiver.
—Measurement chart for determining the constants for a loop antenna.
—How to calibrate your wave meter.
—Circuit diagram of the Cockaday 4-Circuit Tuner adapted for use with dry-cell tubes.

September, 1923

—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

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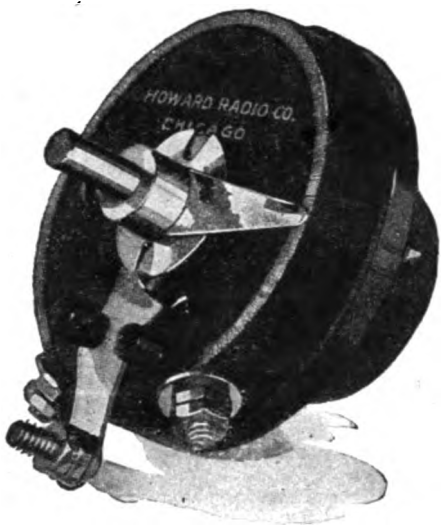

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The newest member of the nationally known Howard line of Rheostats and Potentiometers.

It is practically impossible to obtain satisfactory results with radio frequency amplifier sets unless the potential on the grids is under positive control.

The new Howard Potentiometer, 400 ohms resistance, gives the finest and closest control yet obtained.

This new Potentiometer, on account of its unusual close control, is desirable for adjusting the plate voltage of gas-content detector tubes.

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25 ohms plain	1.10
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Howard Multi-terminal receiver plug. Instant connection—for six pairs of head phones—in series—series parallel—or parallel. Price $2.00.

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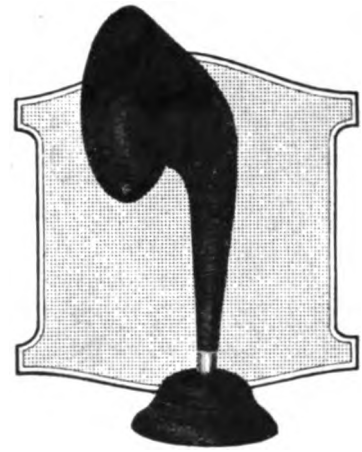

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Yet wait until you HEAR it

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And after its purchase, your enthusiasm lives because there's always that feeling of assurance you possess an instrument of superior tonal qualities.

The Fibertone is scientifically constructed of fiber throughout and amplifies the true tones without vibrative or metallic noises. The outer surface is finished in an attractive black crystalline that rivals its inward beauty of tonal perfection. Operates on one stage of amplification.

#2 Fibertone (14 in.)....$12.50

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FIBERTONE

RADIO HORN

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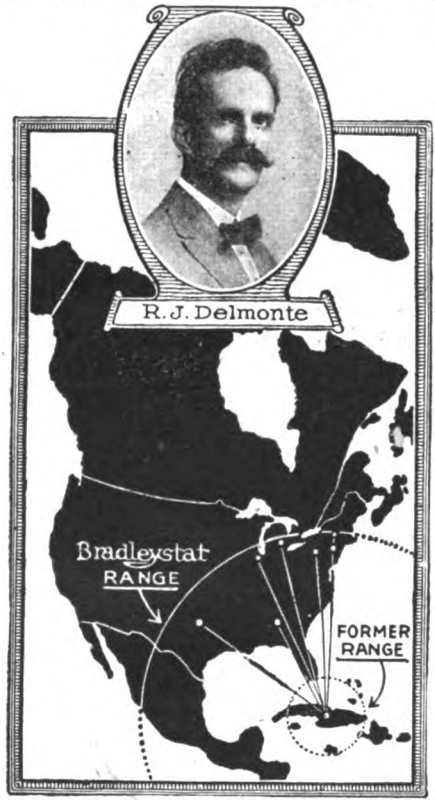
The Universal Bradleystat subdues static in Cuba!



Remarkable improvement in radio reception follows installation of Bradleystats and amazes experimenter in Tropics. Read his letter!

Camaguey, Cuba, July 17th, 1923

"My experimental room is located in the center of Cuba, amidst the Gulf, which is reputed to be the general headquarters of static and all atmospheric disturbances of the whole universe.

I had my sets equipped with wire rheostats having vernier adjustments and my radius of reception was 350 miles from Havana with imperfect reception from Atlanta, Georgia.

After installing Bradleystats, I increased the radius 1000 miles without distortion and picked up Detroit, Schenectady, Pittsburgh, Fort Worth and other stations. When static is performing one of its infernal displays, I lower the filament heat with the Bradleystat to reduce noises. There is only one point of filament heat where this condition is fulfilled and the wire rheostat cannot furnish this with critical detector tubes.

For this reason, I claim the Bradleystat is the only apparatus for controlling filament heat, and if proper adjustment is made, static noises are practically eliminated.

Yours very truly,

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The Universal Bradleystat
provides perfect, stepless, noiseless filament control for every tube on the radio market. Try any tube with the Universal Bradleystat.

Retail Price
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Guaranteed for one year

Beware of Imitations—Avoid Substitutes

Numerous attempts have been made, without success, to duplicate Bradleystat performance by using carbon powder in tubes and other containers instead of the scientifically-prepared graphite discs found only in the genuine Bradleystat. For perfect filament control and uninterrupted performance, be sure to ask for the Bradleystat. The name Bradleystat is embossed on the porcelain container for your protection.

Allen-Bradley Co.
Electric Controlling Apparatus
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THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER TWENTY YEARS

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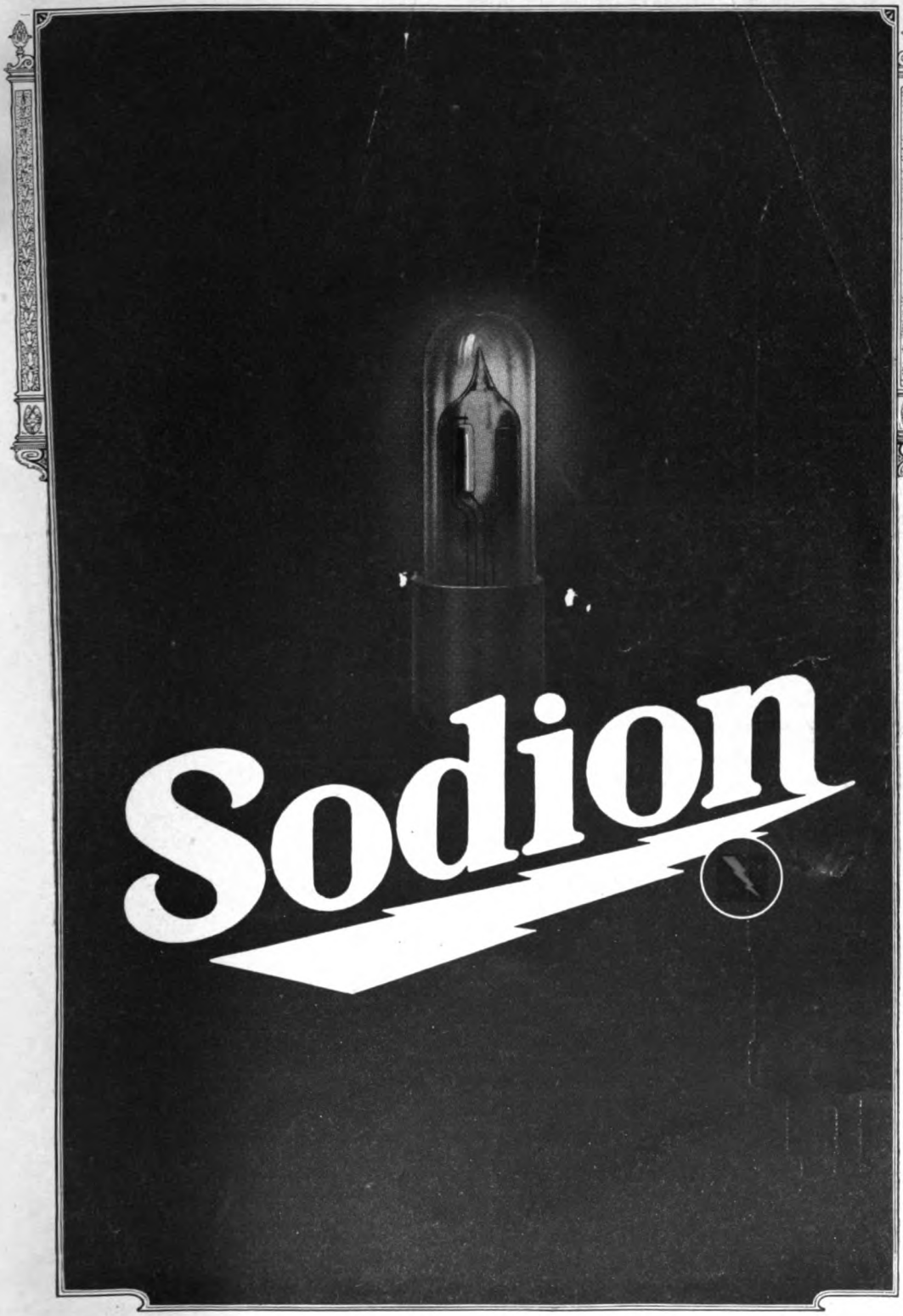

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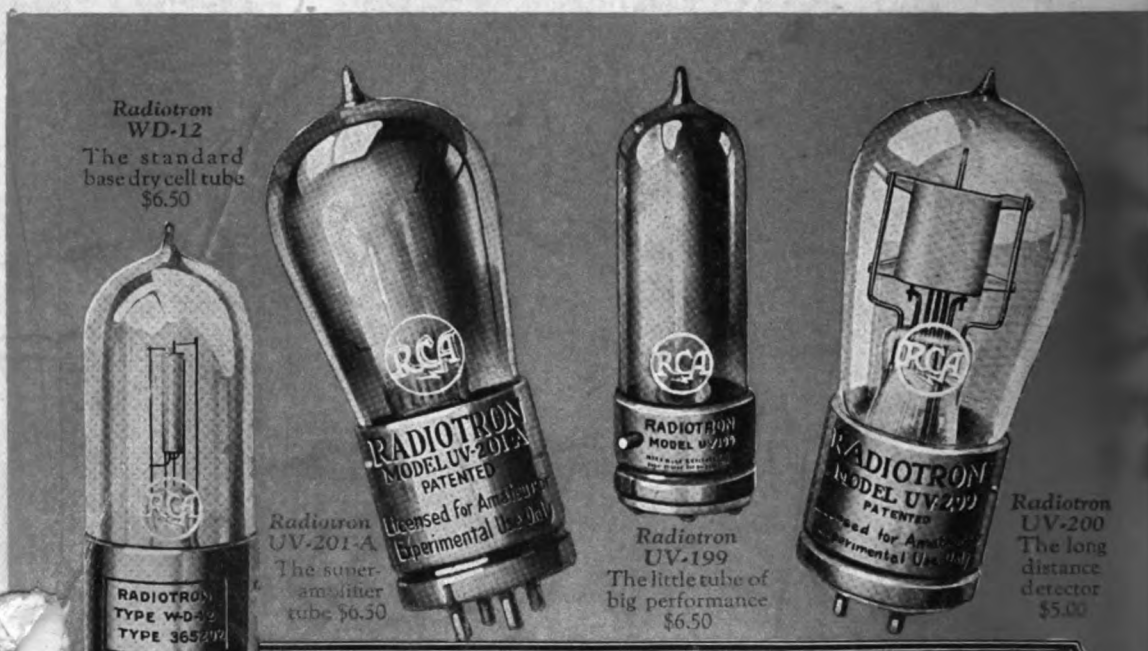

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$6.50

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The super-amplifier tube $6.50

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UV-200
The long distance detector
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Radiotron
WD-11
The ideal dry battery detector $6.50

3,600,000 Radiotrons already made and sold!

This one fact reveals at a glance the growth of radio! 3,600,000 RADIOTRONS already sold! It was the perfection of the RADIOTRON that made popularization of radio possible—and every vacuum tube set needs RADIOTRONS for clear reception and amplification—for sensitivity—and long distance reception.

RADIOTRONS were developed in the world's largest radio laboratories, where hundreds of modern radio achievements had their beginnings. There, they have been steadily perfected to give ever greater service. And now RADIOTRONS have been developed to meet new needs of both transmission and reception. When you ask for a RADIOTRON, take a good look to be sure the name is on it—and the trade mark!

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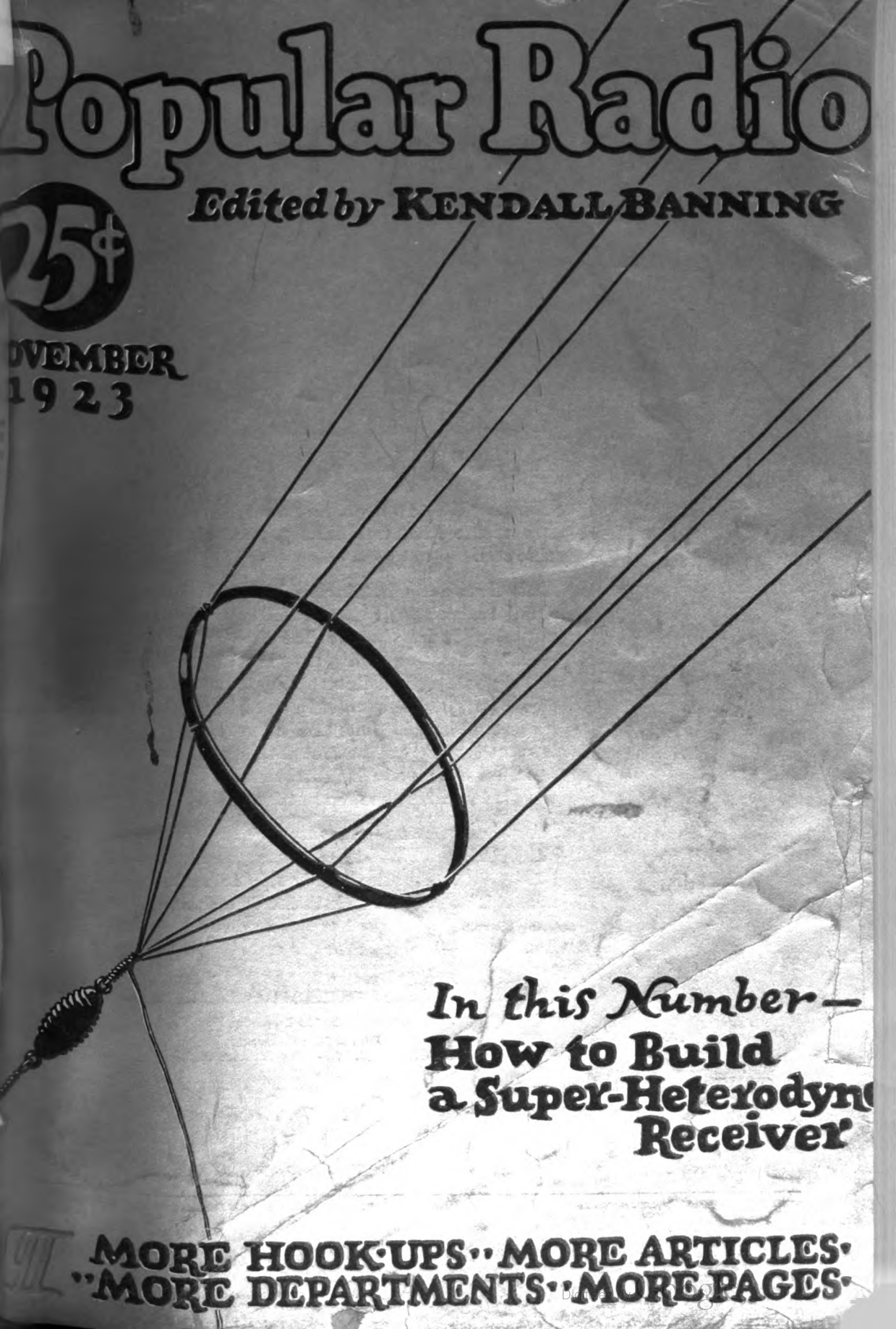
OVEMBER
1923

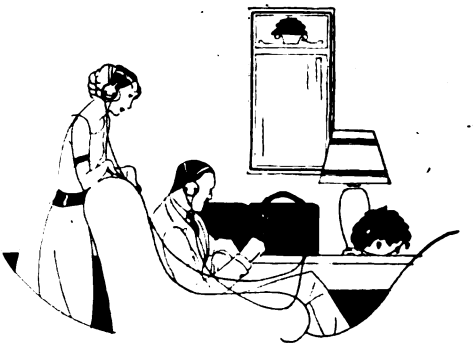


In this Number—

How to Build a Super-Heterodyne Receiver

**MORE HOOK-UPS·· MORE ARTICLES·
··MORE DEPARTMENTS·· MORE PAGES·**

Radiotron
UV-199
For detection or amplification
$6.50



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A Small Tube That's a Big Performer

The new UV-199 is proving a mighty popular member of the Radiotron family, particularly for portable sets.

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Mother lets him wear only a Brandes because it's so much lighter in weight and won't catch in his curls. And she knows that his little ears will be trained to true harmony by the *Matched Tone* qualities of Brandes.

NEW PRICES
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$8.00

C. BRANDES, Inc. **237 Lafayette Street, New York City**

Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(Cover design by Frank B. Masters)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

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"The Wise are free from perplexities." Confucius

Perplexity never comes to the owner of a GREBE Broadcast Receiver—he is truly a Wise man

Doctor Mu

THE 20-foot silk-covered wire, supplied with this Receiver, is the only antenna required. You may conceal this wire behind the picture moulding, or run it along the baseboard of your favorite room.

The attractively finished walnut cabinet has compartments for all necessary batteries.

Write for "GREBE Radio in the Well-appointed Home"

Licensed Under Armstrong U. S. Pat. Nos. 1,113,149

GREBE RADIO

A. H. GREBE & COMPANY, INC., Richmond Hill, N. Y.
Western Branch—451 East 3rd St., Los Angeles, Cal.

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PAGES WITH THE EDITOR

EVERY regular subscriber will find enclosed in his copy of this the November number a green Subscription Order slip that represents a cash value of $3.00—*provided* that he uses it on or before December 15th, when the new subscription rate goes into effect. The green slip is issued to our subscribers in order to give them the privilege of extending their subscriptions for two years longer at the present low rate.

* * *

AFTER sizing up this November issue, now in your hands, the Editor hopes that you will be so pleased with what POPULAR RADIO promises for the future, that you will wish to take advantage of the special offer of two years for $3.00.

* * *

HERE is a double-barreled compliment that comes from the professor of English at Indiana University, who comments not only upon the technical excellence of our articles but also upon the style in which they are presented:

* * *

"I happened to pick up the first issue on a newsstand. I became a subscriber and have not missed a copy since.

"I particularly enjoy the articles on how to make instruments and sets. Your directions are more explicit than I find in other magazines, and your recent practice of stipulating the exact make of instrument used is very helpful. I have on several occasions read elsewhere articles covering the same subject matter as articles in POPULAR RADIO. Without exception I have found your treatment clearer and more to the point. I am a professor of English and I know when an article is well written.

* * *

"I USED to buy all the radio magazines that came out. Perhaps the best I can say of yours is that I am constantly buying fewer and fewer of the others."

—PROF. HENRY THEW STEPHENSON

* * *

OUT in Anthony, Kansas, there lives an ardent radio fan, Leroy Hughbanks, who has for several years carried on his experiments despite what would be to most of us an unsurmountable obstacle—total blindness. "People scarcely realize what radio means to the sightless" he bravely comments to the Editor. "The sightless men in particular have not yet realized what they can do in radio."

NOT only does friend Hughbanks keep up with the development of radio but he builds successfully the sets that are described in this magazine—which will give pause to some of our less handicapped readers who sometimes blame the instructions rather than their own oversight when their set does not work properly at the first trial. Mr. Hughbanks writes:

"LET me once again express to you my great appreciation of that dear old magazine POPULAR RADIO. It is beyond doubt the finest journal on the subject I have found, regardless of price. I have but one criticism; it is by far too small. Make it larger and charge it up to us! We will be glad to pay more for the magazine if you wish to make it bigger and better."

* * *

WE take pleasure in carrying out this reader's suggestion. Beginning with this issue POPULAR RADIO is enlarged by about 56 pages, and the price is 25 cents.

* * *

FROM 'way down east—specifically from Waterville, Maine—comes this gratifying tribute from an ardent reader:

"I am more than pleased with POPULAR RADIO; its pages are filled with information that is priceless to the wide-awake radio amateur. It brings to me the latest news and articles by the best authors who are working to elevate radio in the minds of the general public—and POPULAR RADIO is accomplishing this task with excellent success.

* * *

"To be able to give a concise description of a new circuit or a new piece of apparatus without involving many technicalities, is not a very easy undertaking, but POPULAR RADIO seems to have no great difficulty in doing so."

—D. GILBERT LIBBEY

* * *

CONTRARY to general belief, Brother Libbey, to write and to edit and to illustrate an article so that it will be concise and clear and logical and simple is one of the Editor's most difficult tasks.

* * *

SOMETIMES, when a last-minute rush forces the Editor to send a timely article to the printer without the usual care in preparation, he is prompted to quote the postscript that a famous author once wrote at the bottom of a letter: "Please excuse the length of this message; I hadn't time to make it short."

* * *

WHEN POPULAR RADIO defined its purpose to keep its editorial pages entirely clean and uninfluenced by the business office it merely put into words a policy which the magazine has strictly observed from its very first number. In the protection of its readers no other policy is possible.

* * *

NOT a single article or statement or picture has yet appeared in this magazine that has been published as the result of pressure from advertisers or prospective advertisers. Nor has any article or statement or picture been held out for a similar reason.

* * *

THE Editor cannot state too clearly or too emphatically the simple fact that *"The editorial pages of* POPULAR RADIO *are not for sale."*

(Continued on page 8)

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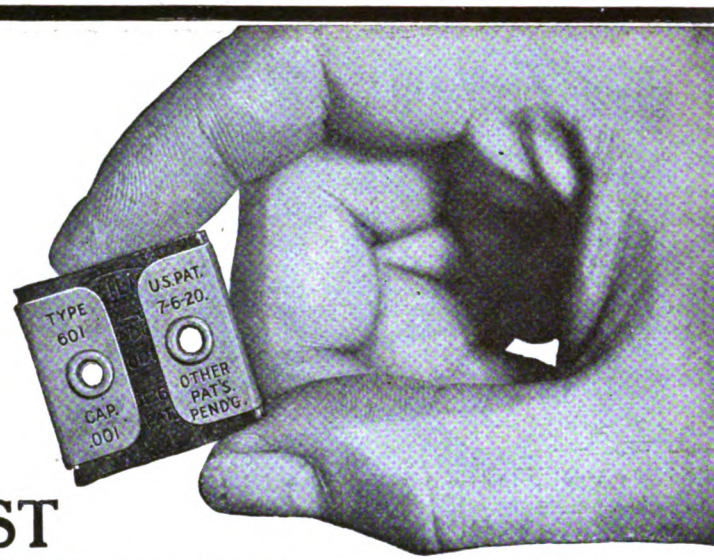

The BIGGEST LITTLE THING *in radio*

Here is the Dubilier Micadon, Type 601, full size.

It is the standard fixed condenser of radio—adopted by nearly all the leading manufacturers of sets and accessories and by discriminating amateurs *because it is permanent in capacity.*

Made in many styles and capacities for any circuit.

Price 35 cents up.

Look for a Micadon in your set.

Here is a list of well-known manufacturers who are regular customers of ours and who endorse Micadons:

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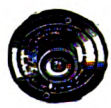
F. A. D. Andrea, Inc.
Bissell Engineering Co.
Bristol Co.
Central Radio Laboratories
Clapp Eastham Co.
Crosley Mfg. Co.
Cutting & Washington Radio Corp.
De Forest Radio Tel. & Tel. Co.
Durham & Co.
Eagle Radio Co.
Freed-Eisemann Radio Corp.
Garod Corporation
Independent Wireless Tel. Co.
Michigan Radio Corp.
Midwest Radio Co.
R. Mitchell & Co.
Murad Laboratory, Inc.
National Airphone Co.
O & T Electric Corp.
Operadio Corp.
Pfanstiehl Radio Serv. Co.
Q.R.S. Music Roll Co.
Radio Distributing Co.
Sec-Tron Radio Co.
Signal Electric Co.
Sleeper Radio Corp.
Telephone Maintenance Co.
J. S. Timmons
Ware Radio Corporation
Western Coil & Electric Co.
Westinghouse Elec. & Mfg. Co.
Whiteland Mfg. Co.
Wireless Improvement Co.

Dubilier Duratran (Radio Frequency Transformer)



Dubilier Variadon (Variable Mica Condenser)

Dubilier Ducon Socket-plug

DUBILIER CONDENSER AND RADIO CORPORATION
48-50 West Fourth Street
New York

DUBILIER DEVICES

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PAGES WITH THE EDITOR

(Continued from page 6)

PERHAPS because this policy is so unusual, it has been difficult for an occasional reader to accept or to appreciate its significance. To be specific, two readers—Mr. R. F. Downs of Medford, Wisconsin and Mr. Brenthal G. Worden of Rensselaer, N. Y.—have questioned the sincerity of this magazine in publishing a description of the Haynes DX Receiver (in the September number) and in the same issue publishing an advertisement of the Haynes-Griffin Radio Service in which the "Haynes Coupler" was listed for sale.

* * *

THE Editor welcomes the opportunity of again defining the policy of POPULAR RADIO by quoting from his reply to Mr. Downs:

"I cannot reiterate too clearly or too emphatically the fact that no influence from the business office of this magazine has ever had the slightest effect upon our editorial policy nor will it have as long as I am Editor of this magazine.

* * *

"THE article written by our Technical Editor, descriptive of the Haynes circuit, is *bona fide* and was accepted solely on its merits. It describes a set which has found favor among radio fans and has proven remarkably efficient. Mr. Haynes has no patent on this set or on any part of the set. The article was written, accepted and scheduled without any consideration whatever concerning the advertising.

"Mr. Haynes is in no better position than any dealer or manufacturer to profit from the publication of this article—except insofar as the circuit bears his name as the inventor of it.

* * *

"THE fact that Mr. Haynes has adapted for use in his set a standard type of variocoupler, gives him no advantages that any amateur or any dealer cannot enjoy; how to adapt this standard type of variocoupler was described in detail in the article; you could make the adjustment yourself.

* * *

"FOR your information I may state that I shall continue to edit this magazine entirely regardless of the advertising pages and I shall neither insert nor omit any article or any item or any picture as the result of influence from our business office."

* * *

CAN any policy be more clean-cut or more sane? Or can it be expressed more clearly?

* * *

RIGHT on the heels of this correspondence, however, comes many letters from readers who not merely endorse POPULAR RADIO'S policy but offer sincere congratulations. From Washington, D. C., for example, comes this word of cheer—from a reader who knows POPULAR RADIO long and well:

"I AM very much interested in your *Pages with the Editor*. They read well and convincingly. Apparently yours is one of the few magazines in the world with a conscience as highly developed as you can maintain it. I rather imagine it was a good thing to put the October argument in, in view of the publication in that number of 'How to Build the Haynes DX Receiver' and the simultaneous advertising of the parts. I rather imagine that it will help others to see that you don't intend to keep out excellent hook-ups or improvements merely because they happen to be advertised either in your own publication or elsewhere, but will publish them if you think it is in the interests of your audience.

"Such an attitude is surely, to use your words 'entirely free from the taint of commercialism.'"

—TROY RODLUN

* * *

WITH this number POPULAR RADIO inaugurates a feature for which the Editor has been preparing for months; it is, in effect, an inter-continental radio news department. Everything of importance that happens in radio throughout the world—all the significant discoveries that are announced, all the researches that are being carried on by scientists and experimenters—will be reviewed briefly by our own technical staff. The essence of it all will appear each month in the new department, *In the World's Laboratories*—starting on page 410 of this issue.

* * *

RADIO has already become an inter-continental interest; it is only a matter of time when listeners in the United States will be tuning in on the European broadcast stations, not as a carefully prepared experiment, but as a daily commonplace. Developments in England, France or Germany will soon be as important to us as are the changes on our own continent.

* * *

IN anticipation of this development POPULAR RADIO now has a special agent in Europe. The Editor is now beginning to give our readers the up-to-the-minute radio news of the *world*—real news, obtained directly and authoritatively from the laboratories where the work is going on.

* * *

If you see it in POPULAR RADIO *it's so!*

Kendall Banning

Editor, POPULAR RADIO

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Sodion

The Plant Behind It

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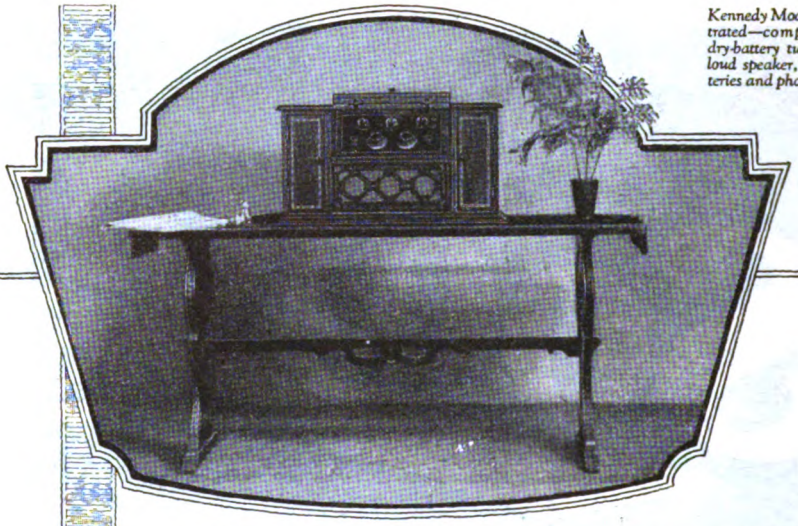

Kennedy Model X—illustrated—complete with 3 dry-battery tubes, built-in loud speaker, all dry batteries and phones, $285.00

Radio Refined and Simplified

The New Radio Unit

Simplicity is apparent—anyone can use it with complete success. No switches—only two dials. Responds to all broadcasting wave-lengths on any type or size antenna. Highly polished Formica control panel. Gold-plated metal trimmings on front, including dials.

All Kennedy Radio Receiving Sets are regenerative—Licensed under Armstrong U. S. Patent No. 1,113,149.

THERE is an air of elegance and *refinement* in the new Kennedy Furniture Model radio sets that truly makes them "The Royalty of Radio." They are designed to harmonize perfectly with artistic furniture and home surroundings. In designing the radio units incorporated in each of these sets the Kennedy Engineering Staff has scored a notable achievement in obtaining high selectivity (avoidance of interference) and long distance reception with the utmost simplicity of operation. Only one dial is required for tuning, and a second dial to control the sound volume.

Each of these new models is complete and self-contained, with internal space for all dry batteries. A built-in loud speaker assures ample volume with remarkable clarity and fidelity of reproduction.

See a Kennedy dealer for demonstration or write us direct for descriptive literature on the new Furniture Model sets.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS SAN FRANCISCO

KENNEDY

The Royalty K *of Radio*

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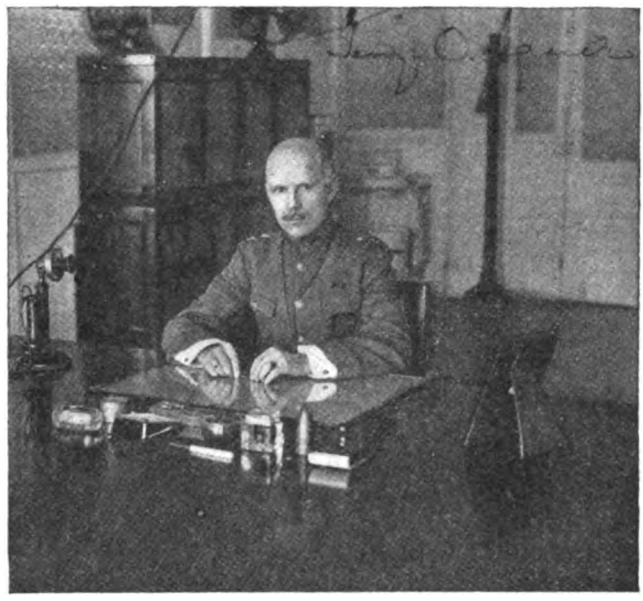

To the Editors of Popular Radio:

"I congratulate you on the excellent standing of Popular Radio. *You have done wonders with it, and I cannot afford to miss a single number."*

Major General, United States Army

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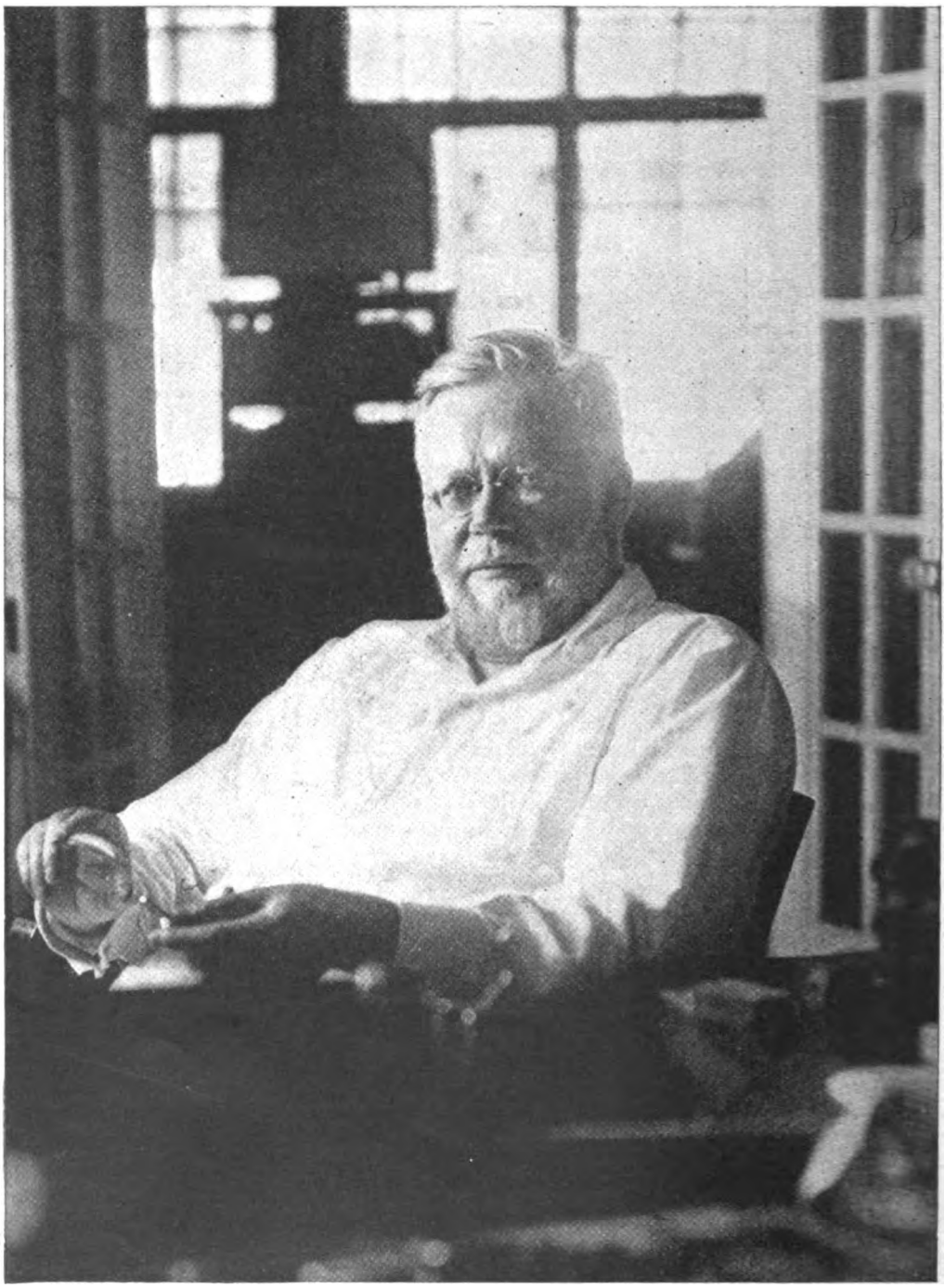

From a photograph made for POPULAR RADIO

He Transmitted Speech by Radio Twenty-three Years Ago

Dr. Reginald A. Fessenden, one of the world's foremost scientists, is not only among the very earliest and most successful experimenters with wireless, but has more radio inventions to his credit than anyone else.

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Popular Radio

VOLUME IV NOVEMBER, 1923 NUMBER 5

How Ether Waves Really Move

The Development of the "Gliding Wave" Theory

Sir Oliver Lodge, Dr. Elihu Thomson and Major-General George O. Squier have discussed in POPULAR RADIO the movement of ether waves around the earth according to the theory of the Heaviside Layer and the alternative theory of Gliding Waves. In this authoritative article the originator of the Gliding Wave theory explains his own views of the matter.

By REGINALD A. FESSENDEN, Ph.D.

THE sliding wave theory appears to have been somewhat misunderstood both by its advocates and its opponents. The nature of this misunderstanding and how it arose will be better appreciated if we consider the general state of the art at the time the sliding wave theory first appeared, in the Proceedings of the American Institute of Electrical Engineers, November 22, 1899[1].

Joseph Henry, who was the founder of wireless telegraphy, had discovered electromagnetic induction and invented the induction coil[2]. He had also made the fundamental discovery that the discharge of a condenser was under certain conditions oscillatory, or, as he puts it, consists "of a principal discharge in one direction and then several reflex actions backward and forward, each more feeble than the preceding until equilibrium is attained." Henry was not only the first to produce high-frequency electric oscillations, he was the first to detect them at a distance, using what was later known as the magnetic detector. The high-frequency oscillations were generated in the upper floor of a building and transmitted to the cellar, where they were received by a receiving coil and utilized to shake out the magnetism from a magnetized needle[3].

Edison, Elihu Thomson and Houston made many experiments on these transmitted waves, and reports of their experiments will be found in Edison's papers in the technical journals of that

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Reprinted from the November, 1922, POPULAR RADIO

DIAGRAM OF THE HEAVISIDE LAYER THEORY

According to most scientists, radio waves are reflected from [and transmitted around the earth by] a layer of ionized gas that is suspended high in the atmosphere of the earth. Sir Oliver Lodge is the foremost exponent of this theory.

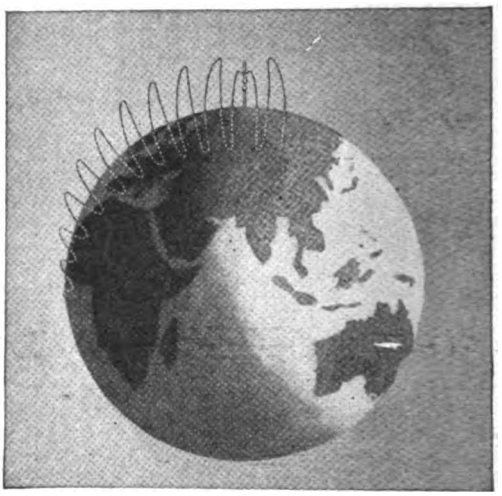

DIAGRAM OF THE GLIDING WAVE THEORY

On the other hand, a number of eminent scientists (of which Dr. Elihu Thomson is one) maintain that radio waves are attached to and glide over the earth, following its contour in much the same way as do the radio waves in line radio.

period and in the paper by Houston and Thomson in *The Journal of the Franklin Institute* for April, 1876[4]. Between 1870 and 1888 von Bezold, Fitzgerald and Hertz had cleared up to a very considerable extent the nature of the phenomena observed, and Hertz's work had shown that the experimenters were dealing with true electrical waves.

Dolbear[5] and Edison had been using vertical grounded antennas for telegraphing wirelessly, though the effects they obtained appear to be mainly electrostatic and only partially true wave transmission.

Crookes in the *Fortnightly Review* for February, 1892, proposed that resonant tuned circuits should be used to select out messages from different stations. Lodge[6] and Popoff[7] had used these waves for signalling, and Popoff, who had used a vertical grounded antenna, coherer and tapper back, pointed out that the apparatus might "be adapted to the transmission of signals to a distance."

Tesla[8], who had been doing a great deal of work in high-frequency oscillations, in 1892 proposed a system for transmitting signals wirelessly using the vertical antennas of Dolbear and tuned transformer circuits at the sending and receiving ends.

Edison, in 1884, discovered and invented the hot-cathode vacuum tube[9], and used it for rectifying high-frequency currents. De Forest's great invention, which consisted of the introduction of a third electrode between the other two, was made about 1907.

Marconi, who had worked under Righi's instructions, had, with the keen eye for commercial opportunity possessed by his race, realized that there was a market for such a telegraphic system, even if working over only short distances, and in July, 1896, gave a demonstration to the English Post Office at Salisbury Plain and succeeded in increasing the range from its previous figure of a half mile obtained by other experimenters to a distance of two miles, using parabolic reflectors and the coherer. In the same year Captain

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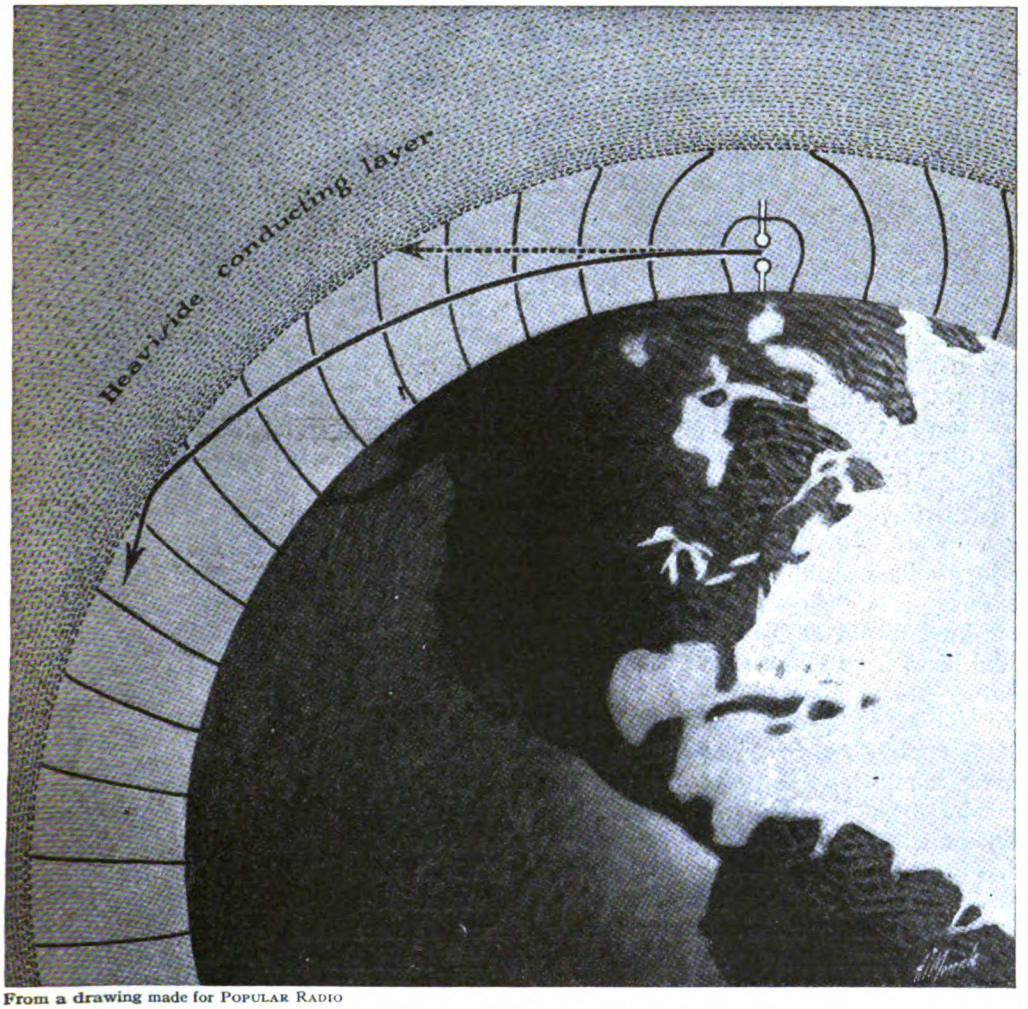

From a drawing made for POPULAR RADIO

DIAGRAM OF DR. FESSENDEN'S THEORY

Instead of moving in straight lines outward from the source, as shown by the dotted line, the waves really move in a curve like that shown by the solid line. But this curve tends to bend away from the earth's surface and reflection from the Heaviside Layer is necessary to bring it back again.

Jackson (now Admiral) of the British Navy found that considerably greater distance could be obtained by using the Dolbear-Edison-Tesla arrangement of vertical antennas and tuned sending and receiving transformers at both transmitting and receiving ends.

Such was the state of the art in 1899. Henry had discovered the method of producing high-frequency oscillations and of detecting them at a distance, utilizing his other inventions, the induction coil and the magnetic detector, for this purpose. Dolbear had invented the vertical antenna. Edison had invented the hot-cathode vacuum tube detector. Tesla had invented the tuned sending transformer and tuned receiving transformer, connecting to the vertical antennas. Marconi, Samuels and Isaacs had undertaken the commercial exploitation of the field. De Forest was about to begin the work which resulted in his invention of the audion.

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But even then the nature of the phenomena involved were not clearly understood. Possibly influenced to some extent by patent reasons there was a strong effort made to show that there was something radically new and strange in the systems which were being commercially exploited. It was stated by a number of authorities that the phenomena were *not* due to high-frequency alternating currents, but that some peculiar "whip-crack" was necessary in the ether. A few quotations will illustrate this point[10].

Professor Cross stated that "alternating currents in the vertical wire will not produce Hertzian waves in the ether, as such waves are produced only by the disruptive discharge. Probably a crude mechanical illustration would be the case of a whip-lash—motions of some kind would be produced, but they would be of a quite different character." Fleming stated that "although in the third claim the patent speaks of employing rapidly recurring or alternating electric impulses, unless some form of a condenser is discharged to cross the spark gap there cannot be any production of Hertzian waves—the disruptive discharge is the one essential condition for the production of Hertzian waves."

Marconi stated that "the difference between Hertzian oscillations and ordinary alternating currents is most certainly *not one of degree*. An analogy may be found in the case of a sound wave in air. The swinging of a bell in a church steeple to and fro will produce no wave, and further, no sound, but if the rim of the bell is struck soundly with a hammer, it effects the air with sufficient suddenness. Hence it appears absolutely clear to me that there is no Hertzian wave telegraphy without the essential feature for producing Hertzian waves, which is the Hertzian spark."

The writer had been lecturing and experimenting on the production and detection of Hertzian waves for a number of years[11], and was convinced that there was no essential distinction between the Henry high-frequency oscillations and Hertzian waves. With the object of demonstrating this a considerable number of experiments were made in 1899, with the assistance of one of the writer's former students, Dr. Kintner, and the results published in the American Institute paper above referred to, that is of November 22, 1899, in which the sliding wave theory referred to by Professor Elihu Thomson[12] was fully explained and illustrated.

It will be seen that this paper on the sliding wave theory was written for a specific purpose, i. e., to show that there was no mysterious "whip-crack of the ether" involved in wireless telegraphy, but merely the well-known high-frequency currents, and though it led to important developments, for instance, the wave chute, the use of the magnetic component of the wave, the loop antenna, the pelorus or wireless compass, continuous wave generation, the wireless telephone and the heterodyne, it was never intended as a presentation of the complete theory.

This has resulted in the theory being misunderstood to some extent. Professor Thomson has supposed, it would appear from his article, that the waves are *entirely* guided by the surface of the conductor and follow the earth around. Eckersley[13], on the other hand, states that the transmission of the half waves is not influenced *at all* by the conductor but "the energy is propagated in straight lines."

The correct theory lies between these two opinions. The original mathematical investigation made by the writer in 1900 shows that the sliding waves are guided by the earth's surface to a quite considerable extent near the origin, but that the effect rapidly falls off. The amount of the bending is expressed by a series formula, the first term of which is an angle equal to half the angle between a tangent to the source and a straight line

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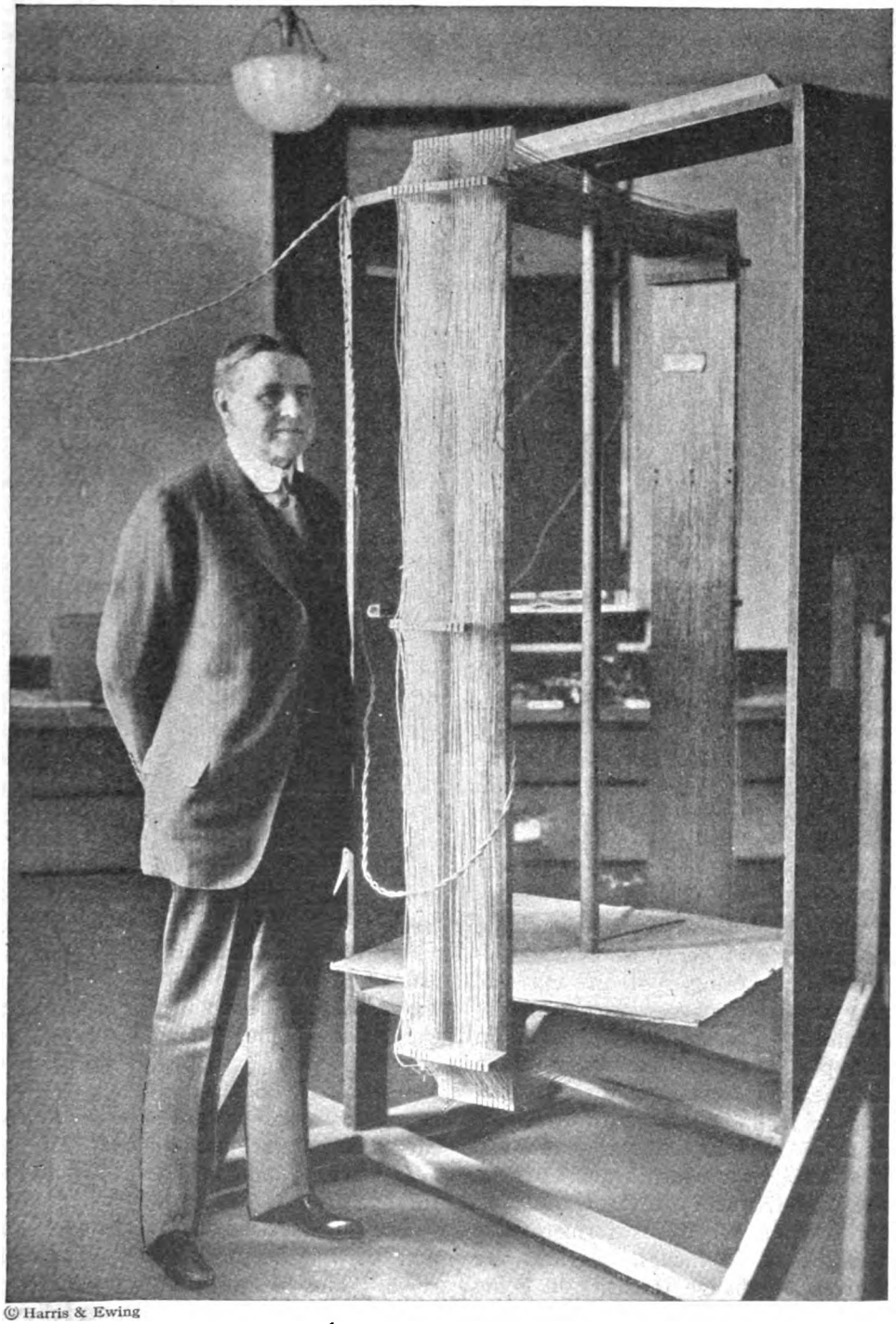

© Harris & Ewing

HOW UNCLE SAM STUDIES ATMOSPHERIC DISTURBANCES WITH A LOOP AERIAL

***Dr. L. W. Austin** of the Bureau of Standards, with the apparatus used for investigating the effects of the ionized clouds described in this article.*

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joining the surface of the conductor at a distance of a quarter wavelength from the source, and the source. The effect of this series falls off very rapidly with the distance. For transatlantic distances it is negligible, but for the distances dealt with in my original paper it is quite appreciable.

The reception of waves across the Atlantic cannot, therefore, be due to guiding of the sliding waves by the conductor and must be due to some conducting layer in the upper portion of the earth's atmosphere.

Writers on the subject of the Heaviside Layer seem to assume that this layer is more or less hypothetical and are apparently not aware that it was investigated fully prior to 1907.

The investigation was begun by the writer in 1900 at Cobb Point, Maryland[14], where two masts were erected one mile apart and by means of hot wire barreters and ring receivers, the exact method of transmission of the waves was experimentally determined[15]. By means of ladders placed at varying distances from the antennas the course of the waves in the air was fully mapped out up to distances of several hundred yards from and to the antennas, and by burying the receivers at different depths in the ground and immersing them to different depths in the sea water, the rate of decay below the surface and the strength of the currents flowing in the surface were accurately determined. The results appeared in papers published by the writer some twenty years ago, where, for example, the figure is given that with a certain amount of salt in the sea water and with a certain wavelength the strength of the high-frequency currents falls off to the fraction 1/e of its former value at a depth of 18 inches. Figures are also given of change intensity in going up and down sloping ground. Later, in 1906, while operating across the Atlantic between Brant Park in Massachusetts and Machrihanish in Scotland extensive measurements were made on the efficiency of transmission of different wavelengths at different hours during the day and night. A curve showing the results was published in 1906[16] and again in 1908[14].

The first point determined, as will be seen from these articles, was that the failure in transmission during daylight was not, as Dr. Fleming had stated and attempted to show mathematically[17], due to absorption in the neighborhood of the sending station. This was determined by measuring accurately and simultaneously the difference in intensity between the daytime and nighttime reception of signals at six different stations at distances of 200 yards, 30 miles, 170 miles, 270 miles, 400 miles and 3,000 miles from the sending station. It was found that there was no difference in the daytime and nighttime transmission for nearby stations, and that the difference increased rapidly with the distance.

A second point determined was the efficiency of different wavelengths for transmission during daytime and nighttime. From the curves given in the papers referred to it will be seen that the absorption increased slightly as the wavelength increased, up to a frequency of 70,000 and then fell off with extreme rapidity. It was for this reason that long wavelength was adopted by the writer for transatlantic working in January, 1906. Up to this time short waves had been used in the attempts to work across the Atlantic, under the impression that they gave a sharper "whip-crack," but as the result of these experiments and the publication of these curves it became generally known that long waves should be used for successful operation.

The third result was the determination of the height of the conducting layer. This is given in section 10 of the article of May 18, 1906[16], as follows:

"The height above the earth at which marked absorption begins to take place may be roughly estimated as about 300

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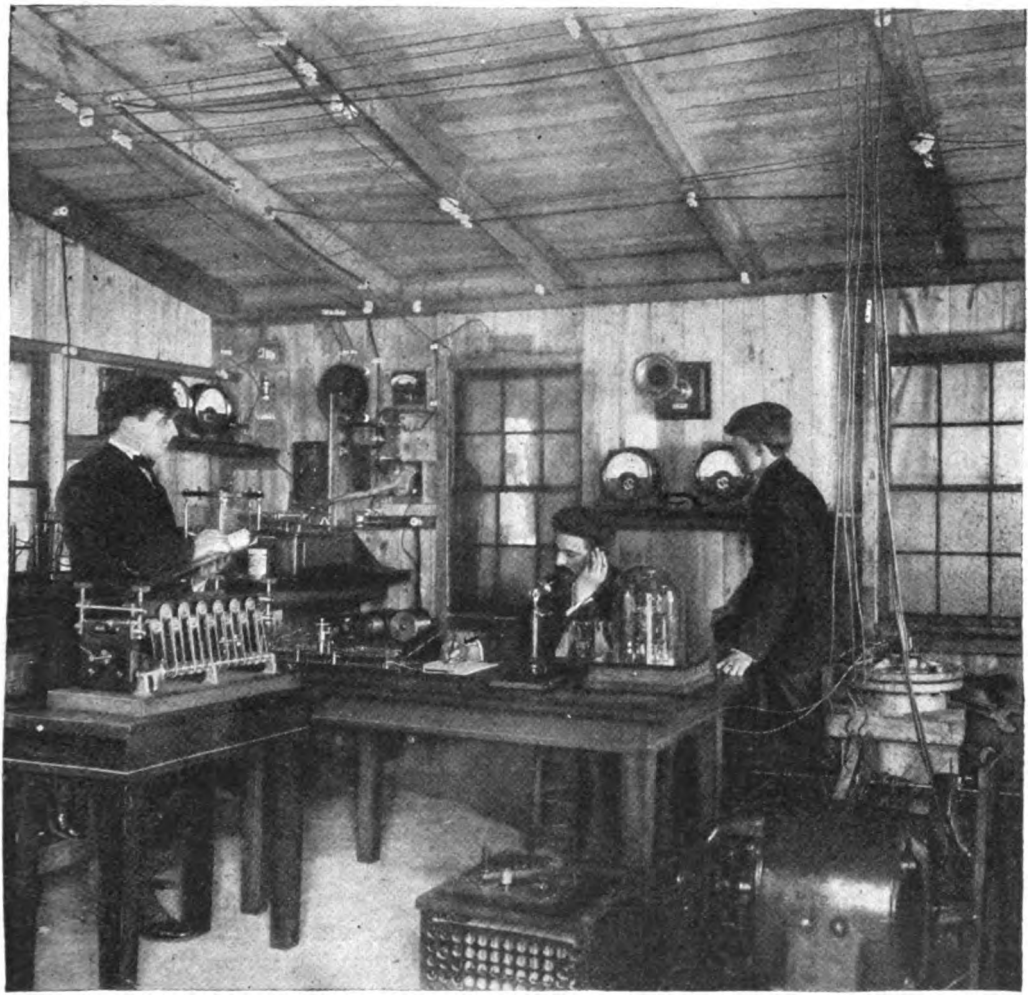

From a photograph in the collection of Dr. R. A. Fessenden

DR. FESSENDEN'S BROADCASTING EXPERIMENTS SEVENTEEN YEARS AGO

As far back as November, 1906, this station was in operation at Brant Rock, Mass. Gramophone music was broadcast from the machine shown in the left corner. This historic picture shows three of Dr. Fessenden's assistants (left to right), Mr. Stein, Mr. Mansbendal and Mr. Guy Hill.

miles at nighttime and 100 miles during daytime."

It will be noticed that the height of this reflecting layer as determined in 1906 from transatlantic wireless experiments agrees almost exactly with the height at which aurora are formed, as determined ten years later by trigonometrical photographic measurements.

The fourth point determined was that the Heaviside Layer was not a smooth surface but was broken up into clouds of ionized air, *"ionephs,"* as the writer has termed them. To quote from the paper referred to, "these masses of ionized air are not continuous but somewhat resemble clouds."

The fifth point determined was the size of these clouds, which is given in the article referred to as varying in diameter from 150 feet to two miles and more.

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The sixth result was the discovery of aeolotropic absorption or the variation in intensity in different directions on different nights.

The seventh point referred to in the paper is the discovery of diffraction effects.

The eighth result was the discovery of a relation between the efficiency of transatlantic transmission on different nights and the curves of variation in the earth's magnetism. The two sets of curves were found to be substantially identical in character.

The ninth point was the discovery of what were called "echo signals." To quote from the article: "On certain nights there appeared to be indications at the Boston station that a double set of impulses were being received, one about a fifth of a second later than the other. It is too early yet to make any definite statement in regard to the matter, but there is some reason for thinking that the second set of signals arrived at the station after going the longer way round. To take an actual numerical example, the strength of signals received at Boston from Machrihanish on the night of January 30 was 480 times that of audibility. If the second set of signals went around the other way, their intensities, according to the square law, would be as 1 is to 70. Hence signals that had gone the other way round would have an intensity of 480 divided by 70, or 7 times audibility. As a matter of fact, the second set of signals, which we may call the echo signals, were really nearly twice as strong. This, of course, might be taken as an argument against their having come that way, but I am not disposed to consider it as a conclusive one. If, however, they did come round the other way, it is evident that the rate of absorption must become uniform after a certain distance."

Though the statement was severely commented upon at the time (May 18, 1906), the existence of these echo signals has since been confirmed. In the January, 1922, issue of the "Monthly Notices of the Royal Astronomical Society," from the Greenwich, Poulka, Uccle and Edinburgh Observatories, Professor Sampson gives curves of "the error in wireless time signals which demonstrate the curious fact that each observatory is liable to be in error by 0.2 second, and that the error frequently persists for some weeks in the same direction. The cause is obscure; lateral refraction due to dissymmetry in the distribution of atmospheric pressure is examined, but is insufficient to explain the whole anomaly."

It will be seen that a quite considerable amount of experimental work had been done on the Heaviside Layer as far back as May, 1906, and it is hoped that someone else may take up work along the lines indicated. Some additional information will be found in a paper on the pelorus published in 1919[18].

Dr. Elihu Thomson and Sir Oliver Lodge have referred to the "scepticism" concerning Marconi's first attempt to transmit wireless signals across the ocean to Newfoundland. This is really a commercial and not a scientific matter.

The reference is, of course, to the disclosures of fact which appeared in the *London Electrician* for November 22, 1907[19]; to the fact that three dots were used as a signal letter; the fact that the receiver used (a carbon-mercury coherer) can be made to give a succession of three dots followed by a period of silence by adjusting the electrodes to the right distance; the fact that no one was allowed to listen in to the signals except Marconi and a single assistant who had no knowledge of electric circuits; the fact that the experiments were abruptly discontinued in spite of the very generous offer of the cable companies to waive their monopoly so far as experimental work was concerned and not only to permit but to assist Mr. Marconi in making any further tests; the fact that we now

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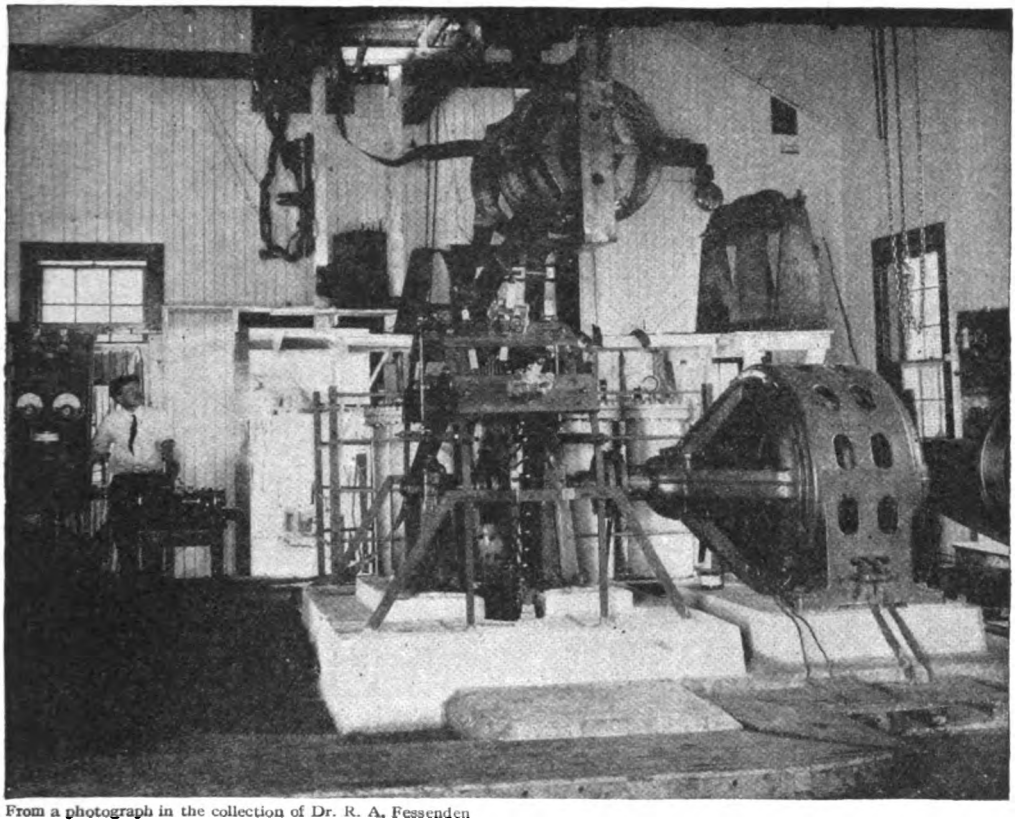

From a photograph in the collection of Dr. R. A. Fessenden

MEASURING THE HEIGHT OF THE HEAVISIDE LAYER

By means of this elaborate transmitter Dr. Fessenden carried on experiments in 1906. The operator, Guy Hill, has since become known to radio fans everywhere as Captain Hill, for several years associated with Major General George O. Squier.

know that with the short wavelength used and with the single, kite-supported wire at the receiving end, the small amount of power and no amplification, no signals could possibly have been received over that distance with that apparatus; the fact that even with the much more highly powered stations subsequently built at Cape Cod it was found necessary to first send the Roosevelt message by cable from the Holland House, New York, and then, after it had been sent out from the Cape Cod station wirelessly, to send a second cable message by the Duxbury cable directing the release of the message cabled from the Holland House; the circumstances connected with the Glace Bay tests as discussed in *The London Electrician* of the date referred to, and the fact that a considerable amount of cable stock had been sold shortly prior to the announcement of the Newfoundland tests. These facts have undoubtedly influenced public opinion to scepticism. But this is a matter on which everyone must form his own opinion, and those who may be inclined to pass harsh judgment should remember that the standard of commercial ethics is not quite the same as that of abstract science.

To conclude, I think that perhaps the most striking evidence of the reality of the Heaviside Layer is the close agreement of the results of the tests made to determine the height of this layer (as given in the paper in *The Electrical Review* for May 18, 1906, cited above)

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with the determinations of the height of the aurora borealis made in 1920. The fact that these two heights agree almost exactly is pretty conclusive evidence of the existence of such a layer. At first sight the aeolotropic transmission referred to in the paper of May 11, 1906, cited above, might be considered as equally conclusive evidence, but it will be seen from the paper of 1919 in *The Electrician* (also cited) that such a deviation would still exist even though there were no Heaviside Layer.

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[1]Reginald A. Fessenden, "The Possibilities of Wireless Telegraphy." (A discussion). Trans. *Amer. Inst. Elec. Engs.*, volume 16, mail edition pages 635-642, regular edition pages 607-614 (1899).

[2]Joseph Henry, "On the Production of Currents and Sparks of Electricity from Magnetism." *Amer. Jour. Science.*, volume 22 (appendix), pages 403-408 (1832).

[3]"The Scientific Writings of Joseph Henry," 1832-1848. The Smithsonian Institution, Washington, D. C. Henry's important papers on electromagnetic induction are reprinted in "The Discovery of Induced Electric Currents," edited by J. S. Ames, volume 1, 107 pages, The American Book Company, New York, 1900.

[4]Edwin J. Houston and Elihu Thomson, "The Alleged Etheric Force. Test Experiments as to its Identity with Induced Electricity." *Jour. Franklin Inst.*, volume 101, pages 270-274 (April, 1876).

[5]U. S. Patent No. 350,299, issued October 5, 1886.

[6]Sir Oliver Lodge, "The Work of Hertz." *Proc. Royal Institution* (London), volume 14, page 321, June 1, 1894.

[7]Popoff, *Jour. Russian Phys. Chem. Soc.*, April 25, 1895.

[8]Nikola Tesla, "Experiments with Alternate Currents of High Potential and Frequency." *Jour. Institution Elec. Engs.* (London), volume 21, pages 51-163 (1892).

[9]U. S. Patent No. 307,031, issued October 21, 1884. See also Edwin J. Houston, "Notes on Phenomena in Incandescent Lamps," *Trans. Amer. Inst. Elec. Engs.*, volume 1, first paper, 8 pages, October, 1884.

[10]Court reports in Marconi *vs.* De Forest, Southern District of New York. Proceedings Electrical Congress at St. Louis; Discussions *Inst. of Elect. Eng.* (England) and "Principles of Electric Wave Telegraphy."

[11]Purdue University catalogue for 1892-93. Thesis, Bennet and Bradshaw, Western University of Pennsylvania, 1895.

[12]POPULAR RADIO, volume 2, pages 231-235, (December, 1922). See also Elihu Thomson, "A Short Story in Wireless," *The Electrician* (London), volume 89, page 148 (August 11, 1922).

[13]T. H. Eckersley, "A Short Story in Wireless" (letter to the editor). *The Electrician* (London), volume 89, pages 242-243 (September 1, 1922).

[14]Where speech was first transmitted wirelessly, December, 1900. See Reginald A. Fessenden, "Wireless Telephony." *Trans. Amer. Inst. Elec. Engs.* volume 27, pages 553-629 (1909).

[15]A. Frederick Collins, "Fessenden's Work in Wireless Telegraphy." *Electrical World*, volume 42, pages 474-476 (September 19, 1903).

[16]Reginald A. Fessenden, "Wireless Telegraphy," *Electrical Review* (London), volume 58, pages 744-746 (May 11, 1906) and 788-789 (May 18, 1906).

[17]J. A. Fleming, "Principles of Electric Wave Telegraphy," pages 617 and 618.

[18]Reginald A. Fessenden, "The Fessenden Pelorus (Wireless Compass); a Caution as to Its Use." *The Electrician* (London), volume 83, pages 719-721 (December 19, 1919).

[19]Reginald A. Fessenden, "A Regular Wireless Telegraph Service Between America and Europe." *The Electrician* (London), volume 60, pages 200-203 (November 22, 1907).

Kadel & Herbert

BROADCASTING A CONCERT FROM A LINER'S DOCK

In the foreground may be seen the microphone that transmitted the jazz of Paul Whiteman's orchestra just before the sailing of the steamship LEVIATHAN *from New York. The innovation made a hit with the radio fans.*

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From a photograph made for POPULAR RADIO

THE HEAD OF UNCLE SAM'S DETECTIVES

Although officially known as chief of the Bureau of Investigation of the Department of Justice in Washington, the author of this article, William J. Burns, is perhaps more widely known because of his career as a sleuth in many important criminal cases.

Radio Puts on Gum Shoes

The applications of radio to police work are limitless. How the Department of Justice, in co-operation with the police departments, is preparing to create a nation-wide radio net for locating and catching criminals is here told by—

WILLIAM J. BURNS

A YOUNG man in a certain city recently called on a large dealer in radio equipment and selected a high-priced receiving set. He claimed to be representing a public school. He took the set away, saying that the money for it "would be brought in later."

When the dealer found that he had been deceived he placed the case in the hands of the Burns Detective Agency. This agency's operators decided to give the case what we call "absent treatment."

That night there went out from a local broadcasting station, a message, somewhat as follows:

> "Wanted: A youth, about 18 years old, 5 feet 7 inches tall, weight about 135 pounds, light hair and eyes, affable, small scar on cheek. He is wanted for procuring illegally a radio receiving set (fully described). A reward of $50 will be paid for information leading to his arrest."

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It happened, as was expected, that at the time the youth was entertaining a group of friends with the outfit which thus poured into their ears the account of his misdoing. They recognized him at once, but with quick wit he warded off embarrassment by saying:

"It's only a chum of mine pulling off what he thinks is a good joke."

But on the next day the youth's mother went to the dealer's store and paid in full for the outfit.

The case, though a minor one, shows how the radio may be used in subtle way for detecting crime. In truth, I believe it will prove to be our single best medium for pursuing criminals in many kinds of difficult cases. It will thus rank among the best of crime preventives.

That is the thought that we, who plan to nationalize this new instrument of crime detection, have of the radio as an arm of law and order.

It is to be a first feature in the operation of the National Bureau of Identification and Information hereafter to be carried on by the Bureau of Investigation, U. S. Department of Justice.

The new bureau is to be taken over rather than set up. For nearly twenty-five years it has been operated in Washington, D. C., by the National Association of Chiefs of Police. To it have come copies of identification material collected by the police of large cities—material that consists of photographs, fingerprints, Bertillon measurements and records of individual offenders of the more or less professional class of criminals. It now has on file probably a million items of information relating to several hundred thousand criminals. New items reach it now at the rate of perhaps 40,000 a month.

Through it large police departments and detective agencies exchange data that are of mutual value. Its biggest service has been in making identifications.

Although of much value, this bureau has not been adequate to the need for a national clearing house on crime for various reasons.

One reason is, that because of its semi-private nature, there are facilities which it could not use to the fullest extent. There is the radio, for instance, but this can be used with fullest effect only through some form of broadcasting service.

In order that it be able to make use of such a service as well as many other things now beyond its range, the Department of Justice has agreed to take over the activities of the bureau and hereafter operate it. This move is in furtherance also of a policy laid down, upon his taking office, by Attorney General Daugherty with reference to the Department of Justice's investigating bureau. It was to make this bureau an all-round agency for public service, especially in the prevention of all crime. Through it we have tried to bring all the crime detecting agencies of the country into a form of co-operation that will enable them to work as a single unit in protecting the public from the criminal, and in detecting crime.

This aim will be greatly advanced by the National Bureau of Identification and Information, for under government operation the bureau will be of service to peace officers of all kinds, the rural county sheriff as well as the big city chief of police, the village constable as well as the large private-detective agency. In fact, we hope to get them all to supply it with as well as to draw upon it for information.

We expect also to make it an all-round storehouse as well as clearing house for crime data. There will be a statistical office—the first of national scope, to collect regularly numerical data, such as used to be gathered periodically by the Census Bureau; however, the data will be more up to date and more inclusive. There also will be a library where we expect to keep on

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From a photograph made for POPULAR RADIO

The Radio Detective Who Unfathomed the Famous "Nauen Buzz"

During the early days of the World War the incredibly rapid and undecipherable radio signals between the most powerful broadcasting station in Germany and the station of the "Telefunken Company" at Sayville, Long Island, N. Y., aroused the attention of the U. S. officials. But it was a radio amateur, Charles E. Apgar of Westfield, N. J., who finally found the solution by means of amplifiers that recorded these signals on wax phonograph cylinders. By this means the messages were de-coded—and the Long Island station was promptly seized. This picture shows Mr. Apgar operating the same apparatus which he used on that historic occasion.

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AS THE PICTURE WAS SENT—

The Jenkins apparatus for transmitting and receiving pictures by radio (as described in POPULAR RADIO *for April, 1923), is already being used for sending motion pictures in the same way.*

—AND AS IT WAS RECEIVED

The device, in effect, "draws pictures with pencils of refracted light." Note the steel engraving-like quality of the received portrait.

file every book, report or other published item of material having to do with crime. We hope to make it so complete that even any general student of crime may go there and get full and accurate information having to do with all phases of the subject.

But the big function of the Bureau of Identification and Information will be the quick dispatch of information respecting crime and the pursuit of criminals. In that purpose radio will be used on a national scale, and it will thus be made available to all peace officers. In many cases it will greatly expedite pursuit and speed up interchange of information to a degree beyond what is now possible through any other medium of communication.

A serious crime, let us say, is committed in Massachusetts or Texas. The offender drops seemingly, as the reporters often say, "out of existence." With the bureau in full operation and the government's radio facilities at its command, all space may cry out for his apprehension. No matter how fast or how far he may go, the radio will dog his footsteps—it, indeed, may pour into his own ears an inescapable harbinger of discovery.

For a flash by radio from an officer of the law anywhere in the country may rally against the fugitive every pursuing agency in the country, and do it almost instantaneously.

In many cases the radio will be able to send forth much more than general descriptions of the fugitive. If he happens, for example, to be recorded in the official archives of crime, his finger-prints and even his photograph may be broadcast, by a single operation, throughout the country.

In that case the officers of the law at the scene of the crime would need only to file a simple telegram to Washington, saying, for instance, no more than the following:

"We want No. 1162. Broadcast."

A clerk in the Washington bureau,

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Courtesy of Perry Armstrong

HOW RADIO WAVES TRAP THIEVES OF COPPER

Coils of wire, concealed behind the casings of the doorways of an Austrian factory and connected with similar coils at the door of the watchman, tuned to resonance by the use of inductance and capacity in variable units, permits the detection of a piece of copper as small as four square inches.

with nothing but the number as guide, could turn to a file and get all information needed for broadcasting full data regarding the criminal to all parts of the country.

The information will include fingerprints and photographs and histories of every important criminal arrested anywhere in the country.

It is now possible to transmit fingerprints by either telegraph or radio. Among the several recently invented methods of doing this is a process recently devised by Hakon Jörgenson of the University of Denmark. It consists of a system for reducing fingerprints to numerical formulas. By means of it a fingerprint at one place may be sent to another place in some such formula as the following:

"$14 \times 6 - 5 - 8 \times 10 - 142 \times 152$."

With such formulas at hand, the expert can construct the essential parts of the print. Hitherto, fingerprints could be transmitted from one place to another only by mail or in person. This often caused serious delays in carrying on investigations. A suspect would be arrested, say, in San Francisco. The only way to determine positively whether he was the person wanted would be by comparing his fingerprints with ones on file, say, in New York. Thus a week or more would elapse before duplicates could be transmitted from the one place to the other.

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Courtesy *The Tribune*, N. Y.

A POLICE PORTRAIT TRANSMITTED BY RADIO OR WIRE

With the aid of the geometric chart shown on the page facing, portraits are broadcast by the Italian Home Office in Rome; a special staff of men are employed for sending and receiving not only portraits but fingerprints.

In international cases there often is several weeks' delay. Now, however, a fingerprint may be transmitted by radio or telegraph in an hour's time. Indeed, by means of radio it may be broadcast to all the ends of the earth.

The same may soon be done, also, with photographs—thanks to the invention made by C. Francis Jenkins of Washington, D. C.* By means of the Jenkins machine the actual portrait may be transmitted. This will vastly expedite identifications when the system is applied to police methods, as it will insure quick and wide distribution to the means by which fugitives may be recognized at sight.

By means of radio photography it may be possible, for example, to have posters containing a photograph of a fugitive on display in every locality of the country within a few hours after a crime is committed.

The essence of strategy in fighting crime, as in war, is speed. As a famous general once put it, success depends on "getting there furst'est with the most'est men." The essence of crime prevention is certainty of apprehension and punishment—but the criminal must be caught before he can be punished.

Both prevention and apprehension will be aided by the radio, once it is applied in the full, as by no other system or device yet invented.

One may telephone or telegraph by one operation in a single direction only. Despite the vast network of wires that now stretch over the country there are

*See POPULAR RADIO for April, 1923.

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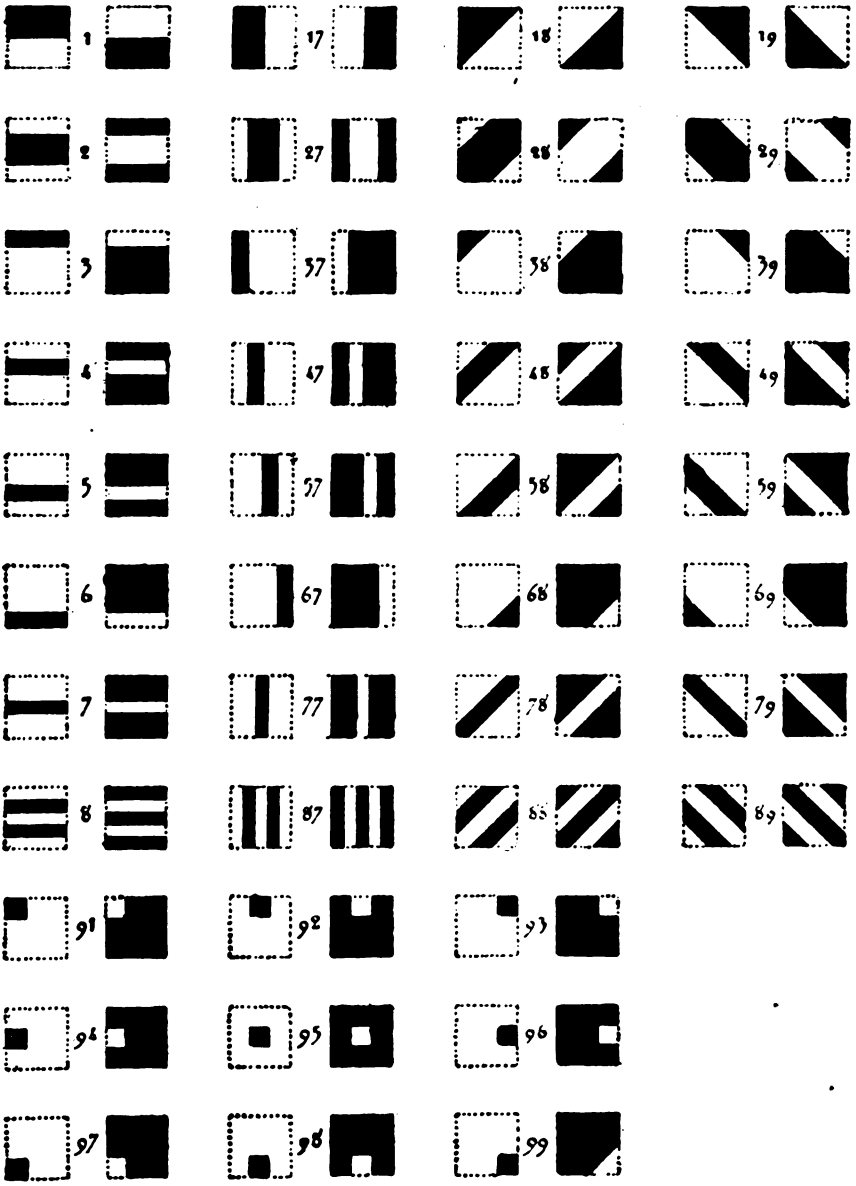

THIS CODE CHART IS THE BASIS OF THE "ELLERO SYSTEM"

By means of these shaded squares, designated by numbers, a picture may be literally dissected into units similar to the units of a halftone screen, and re-assembled by numbers transmitted by wire or radio. This system was invented by an Italian code expert, Commendatore Ellero.

many spaces only sparsely touched or not at all by them. The police of New York and Philadelphia, for instance, may "burn" the wires in making a joint pursuit of a fugitive while the criminal drops into some isolated community between those cities and lets the winds of pursuit blow harmlessly by. With the radio every locality wherein the criminal possibly could take refuge would be reached at the same time with calls for his arrest.

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This is now being demonstrated locally by several city police departments, notably those of Chicago and Detroit. In the first city, I am informed, the scout cars of detectives are equipped with receiving sets through which the operators can be reached from headquarters at any time, and be kept informed with developments as they work.

In both cities the radio is being used with particular success in the matter of automobile thievery. Every day names and numbers and descriptions of stolen cars are broadcast into all surrounding country, with the result that thousands of eyes are put on the watch for these cars.

Incidentally, it should be possible, through the radio to reduce to *nil* automobile thievery, which as a rule depends for success on quick get-aways over open roads. With officers and garages and the great number of amateur radio fans, whose aid could be secured quickly, kept informed along the highways of escape, it should become well-nigh impossible for a thief to make his escape with a stolen automobile.

The automobile as a means for the quick pursuit of criminals is offset to a great degree by the fact that it can be used almost as well by fugitives themselves. Indeed the criminal, I have no doubt, will learn to make use of the radio, not only in making escapes but also in accomplishing crimes.

This latter is made difficult by the

From a photograph made for POPULAR RADIO

WHERE THE RECORDS OF LAW-BREAKERS ARE KEPT

Into these files of the National Bureau of Identification and Information at Washington pour monthly about 40,000 items of information about criminals. Radio will play an increasingly important part in both collecting and disseminating this data for police uses.

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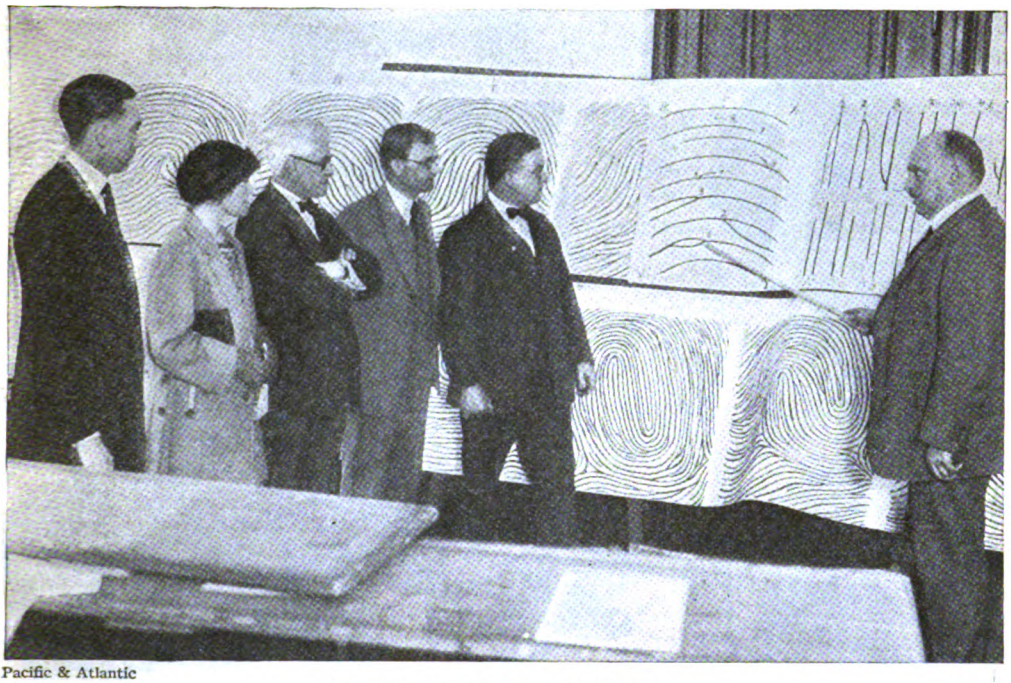

Pacific & Atlantic

FINGER PRINTS BY RADIO

Hakon Jorgenson, sub-director of the Copenhagen police and inventor of a finger-print classification system that permits the transmission of these identification marks by radio, is demonstrating his invention to the New York police experts. The plan is based upon numbers for curves, valleys and whorls.

fact that track of stations can be kept, but it will be relatively easy for the fugitive to carry his own receiving set and by means of it keep reasonably well informed as to what is done *via* radio by those in pursuit of him. But again, as illustrated by the case of the youth who stole the receiving set, this very fact may be turned upon and used against the fugitive. In truth, the "psychological" possibilities along this line are limitless.

These lines of development will cause the radio to serve as a great crime preventive. The very knowledge that radio is available for full use in pursuit, that it can reach him no matter where he may go, should have and must eventually have a restraining influence upon the criminal.

And it is the prevention of crime which is the prime aim of every conscientious peace officer. And it is crime prevention that we hope for most through the work of the Bureau of Identification and Information and its chief arm, the radio.

It will give us something we have long needed and under our system of government cannot have except by voluntary action—a central establishment through which all crime-pursuing agencies may work together, particularly in the matter of crime prevention.

In European countries all policing activities generally are directed by national bureaus or departments. That is probably why several of them already have gone further than we have done with the radio as a policing agency. In France it has been in general use for some time, and it has been successful.

Among the more striking examples of the use of radio in detecting crime may be included the following report from Mr. Armstrong Perry, who has been

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Keystone

IN THE BROADCASTING ROOM AT POLICE HEADQUARTERS

New York City owns one of the most efficient radio stations in the country, WLAW; the uses of it, however, have not begun to be realized. Receiving apparatus has been installed at headquarters of each of the five boroughs.

touring Europe and picking up items of interest for the readers of POPULAR RADIO. He writes as follows concerning the illustration published on page 351:

By the guilty expression on the face of Hofrat Dr. Max Reithoffer as he steps through a suppositious doorway with a theoretically stolen plate of copper and by the reproving attitude of Ingenieur Emil Wolf, his assistant, it is easy to see that the apparatus shown in this picture is the latest thing in radio thief-catchers.

Morals in Austria were not much after the war. Theft and pilferage became almost as common as in the United States, where they drove to the wall several of the leading insurance companies that guaranteed policyholders against such risks. Dr. Reithoffer, at the head of the government technical institute's radio department, was besought by numerous manufacturers, tradesmen and building contractors to devise some means for detecting pieces of copper that were being carried away from the premises where they belonged by workmen who did thieving as a side-line. He responded by inventing the system shown in the picture.

It is simple, now that the problems involved have been solved. Any doorway used by departing workmen is supplied with a coil such as that through which Dr. Reithoffer is seen stepping. The wires are concealed behind the casing, of course. From this coil wires lead to a similar one at the door of the watchman or detective who may be near or several hundred yards away. The two coils are tuned to resonance by the use of inductance and capacity in variable units. So delicately is the apparatus adjusted that four square inches of copper concealed in the pocket of a light-fingered workman will disturb the balance and signal the watchman, who, thus warned, loses no time in apprehending the guilty one. The large plate carried by the inventor was used only because it would show up well in the photograph; it is several times the size of the smallest plate to which the apparatus will respond.

One of the difficulties encountered in perfecting the device was that it persisted in sounding alarms for watches, pocket knives and other metal articles that the workers had

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a perfect right to own and carry. Adjustment had to be made so that it would signal: "watch and knife plus stolen copper."

The photograph was taken at *Das Elektrotechnische Institut der K.K. Technischen Hochschule* in Vienna, where Dr. Reithoffer has been a professor for twenty years. He prefers not to give fuller details at present as he has no attachment for signalling to Vienna when ambitious imitators try to get away with valuable ideas pilfered from others.

In this country radio can be used with fullest efficiency only when main reliance is placed on the facilities possessed by the Federal Government. The big broadcasting stations of the army and navy may thus be utilized to serve all the peace officers of the country, and in so doing will bring all of them into closer working harmony. This also will be voluntary, thus giving us the benefits without the risks attaching to a national department of police.

We hope also to develop the idea internationally. The bureau we are to operate will be at least the nucleus of an international clearing house on crime—something which (as recently pointed out by Sir Basil Thomson, late of Scotland Yard) is a vital need. This will be facilitated by radio, and especially by the numerous stations abroad already owned and operated by our government.

Many details bearing upon our plans are yet to be worked out. But I see no obstacle in the way of solving them.

When they are fully applied a tremendous force will have been brought to bear against the world of crime. Already, I understand, more than a million and a half amateur radio fans operate receiving sets in this country. In certain situations they can be of inestimable service in fighting crime. This can be done through the aid they can give in distributing information quickly and widely and also in keeping eyes out for fugitives from justice.

Photonews

AN AERIAL IN YOUR WINDOW SHADE

Wires running around just an ordinary roller window shade is the novel device worked out by W. H. Bullock of New York. "Tuning is accomplished by pulling the shade up or down" is the report that accompanies the picture.

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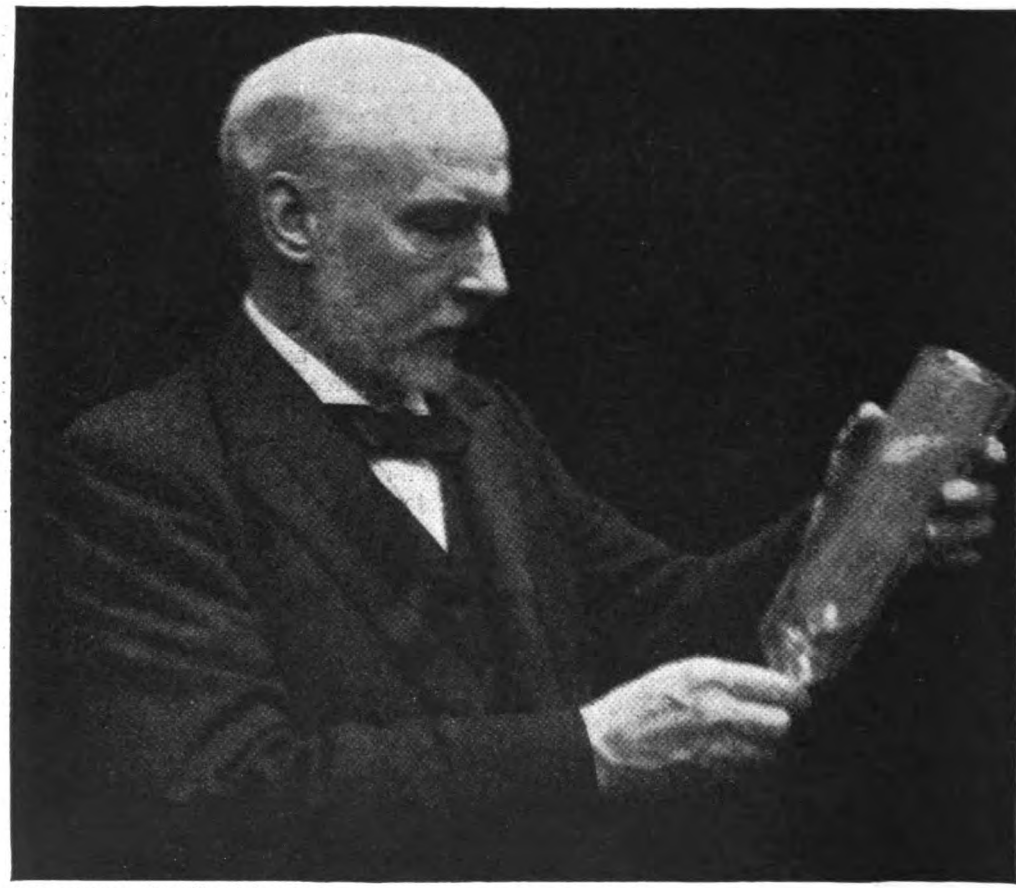

From a photograph by Hoppé, London

The Inventor of the Superfreeze

THE manufacture of vacuum tubes for radio use owes much to Sir James Dewar, Ph.D., LL.D., F.R.S., F.I.C., F.R.C.S., who was a pioneer investigator of the properties and uses of liquid air. By a series of new methods and devices which he invented Sir James succeeded in liquefying not only air but hydrogen, oxygen and several other gases. These novel liquids, never before seen by man, were intensely cold. Some of them reached temperatures as low as 450 degrees below zero, Fahrenheit. In order to keep these liquids and use them in experimental work it was necessary to invent a new kind of cold-proof container, and Sir James produced the double-walled vacuum flask, now familiar as the household thermos bottle. This conquest of extreme cold, so that it can be used in the laboratory as easily as any other reagent, has been an important item in the production of the nearly perfect vacuum which is necessary in some kinds of radio vacuum tubes, as was described in POPULAR RADIO for October, 1922.

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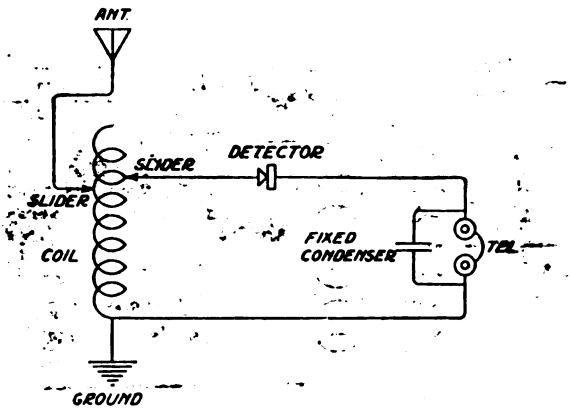

THE CONDUCTIVELY-COUPLED CRYSTAL CIRCUIT

Cost of parts: Not more than $10.00.
Selectivity: Fairly good.
Operation: Very simple. Only two controls are used; a primary and a secondary slider.
Ease of construction: No technical knowledge necessary.
Approximate range: 15 miles.
Outstanding features: This circuit is especially suitable for the beginner who wants to start out by building the simplest set that will give him clear reception of local signals at the smallest cost.

The 100 BEST HOOK-UPS

INSTALLMENT NO. 1

A carefully compiled list of the most efficient receiving sets and the approximate costs, range and peculiarities of each; selected for the practical guidance of the radio novice

IN choosing these circuits, careful consideration has been given to the various uses to which the apparatus may be put. The circuits have been rated under six different classifications which, it is believed, will enable the radio fan to pick out the one that is most suitable for his own particular needs. One hundred picked and tested radio receiving circuits, each one of which is best for its own particular field of usefulness, will be included in this hook-up series for the special benefit of the man who is undecided as to just what he wants. In his selection he will be influenced by (1) *the cost* of the parts; (2) *the selectivity* of the set—particularly if the experimenter is near numerous stations; (3) *the ease of operation;* (4) *the ease of construction;* (5) *the approximate range,* and (6) *the outstanding features* of the set.

The approximate ranges here given are yearly averages on actual records made with receiving sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, under the best of conditions, the actual ranges have been known to exceed the values given by as much as 500 percent.

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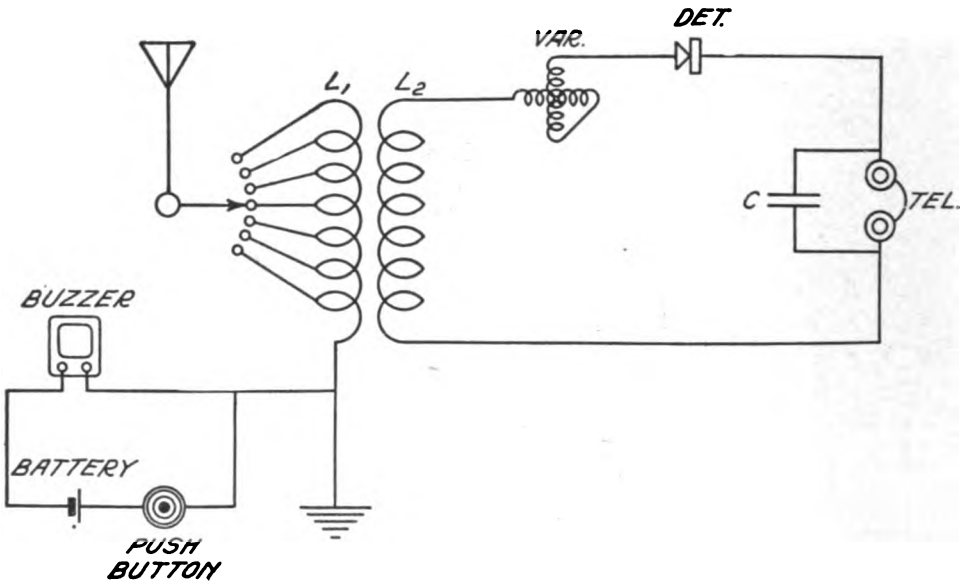
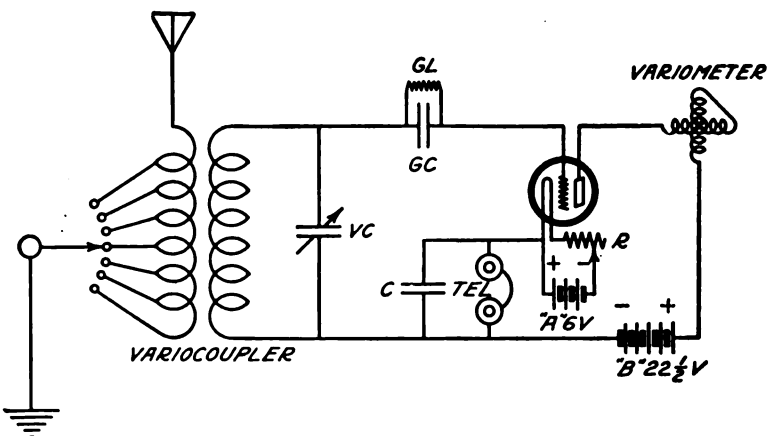


THE INDUCTIVELY-TUNED CRYSTAL CIRCUIT

Cost of parts: Not more than $15.00.
Selectivity: Good.
Operation: Fairly simple. The antenna circuit is tuned by a tapped switch, the secondary by a variometer and the coupling is varied by rotating the secondary coil of the vario-coupler.
Ease of construction: Easy to build.
Approximate range: 15 miles.
Outstanding features: The set is sharp to tune on account of the loose coupling that can be employed, and it has a test buzzer which is a great help in setting the crystal in adjustment.



THE COMBINATION TUNED-PLATE, ULTRA-AUDION CIRCUIT

Cost of parts: Not more than $25.00. (Note: The cost of tubes and batteries is considered "extra," and is not included in the costs given in these descriptions).
Selectivity: Excellent.
Operation: Requires considerable skill which can be acquired in a couple of months of experimenting with the tuning.
Ease of construction: Just an ordinary acquaintance with tools, but some electrical ability in wiring up the circuit is necessary.
Approximate range: 500 miles.
Outstanding features: Exceptionally suitable for DX amateur work on CW. Tuning is very sharp and easy when it is learned correctly.

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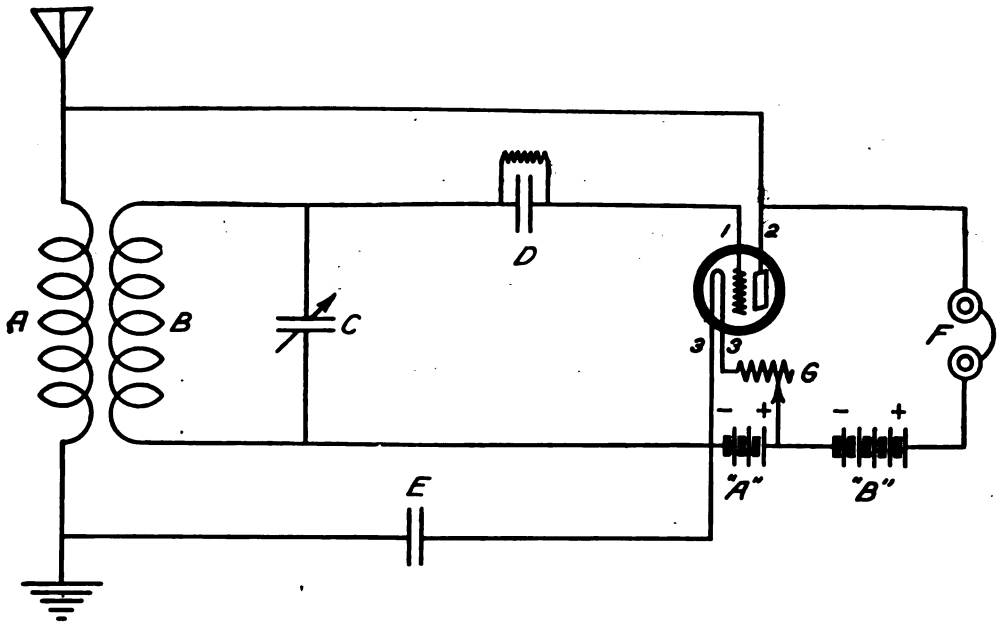
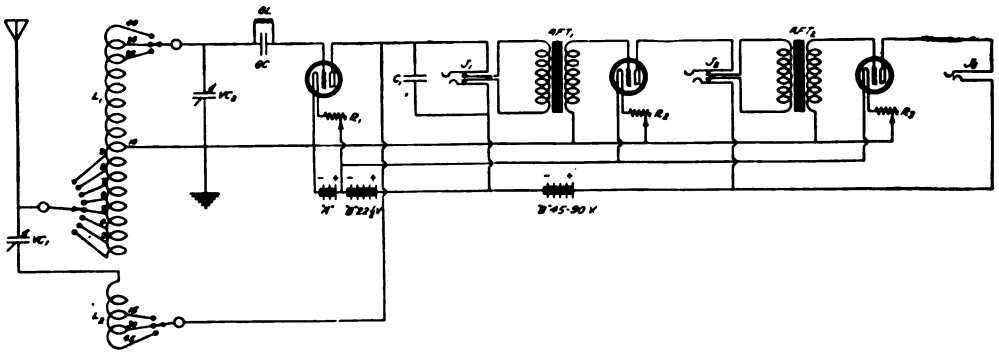


THE MAN-DAY SINGLE-CONTROL REGENERATIVE CIRCUIT

Cost of parts: Not more than $12.00.
Selectivity: Excellent.
Operation: Very easy. Only one control for wavelength. Regeneration is adjusted with the filament rheostat.
Ease of construction: Simple.
Approximate range: 500 miles.
Outstanding features: This is the simplest regenerative circuit to tune. It is very selective and costs but little.



THE REINARTZ CIRCUIT, WITH 2 STAGES OF AUDIO AMPLIFICATION

Cost of parts: Not more than $35.00.
Selectivity: Excellent on amateur wavelengths, very good on broadcasting wavelengths.
Operation: Easy when mastered; about a month's practice should suffice to become well enough acquainted with the peculiarities of the tuning.
Ease of construction: Simple.
Approximate range: 1,500 miles.
Outstanding features: It is noted for its DX amateur reception and its low cost.

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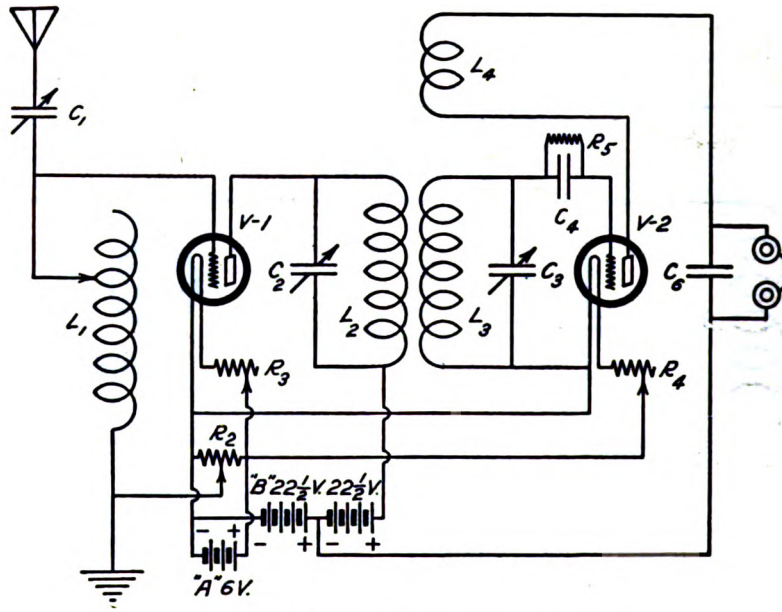
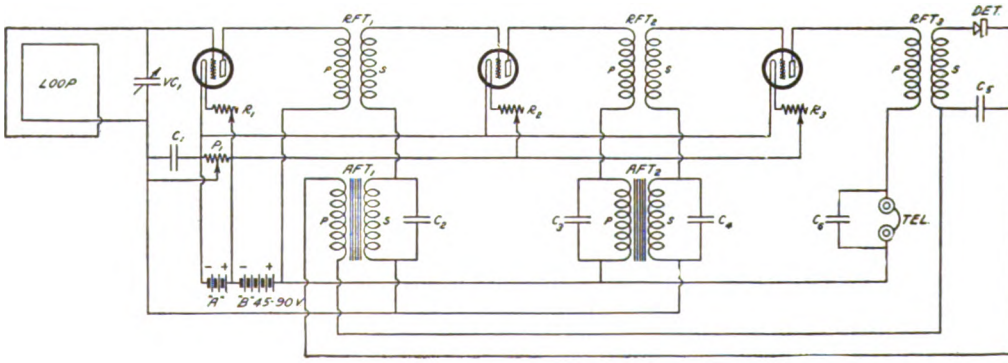


TUNED RADIO-FREQUENCY AND REGENERATIVE-DETECTOR CIRCUIT

Cost of parts: Not more than $28.00.
Selectivity: Good.
Operation: Rather complicated for a beginner.
Ease of construction: Easy.
Approximate range: 500 miles.
Outstanding features: May be used with short indoor antenna. It may be made from a single-circuit, honeycomb set to stop re-radiation, and may be used to give the builder a good idea of radio-frequency amplification before he tries out the more complicated circuits.



THE SQUIRE REFLEX CIRCUIT

Cost of parts: Not more than $50.00.
Selectivity: Excellent.
Operation: Very simple. One control for wavelength and one control for regeneration; the only other adjustment that must be made is the setting of the crystal detector.
Ease of construction: More or less complicated. There are a number of precautions that must be taken to get the circuit to operate at highest efficiency.
Approximate range: 500 miles (with the loop antenna).
Outstanding features: No outdoor antenna is needed for DX reception. Simplicity of tuning.

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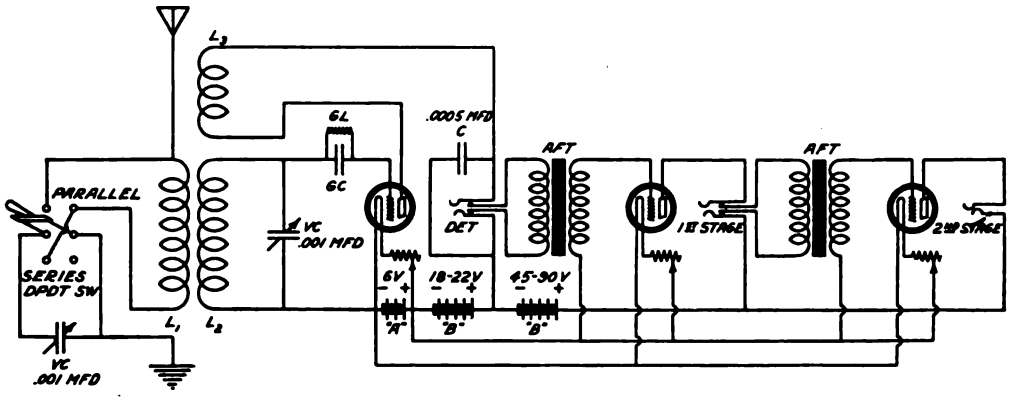
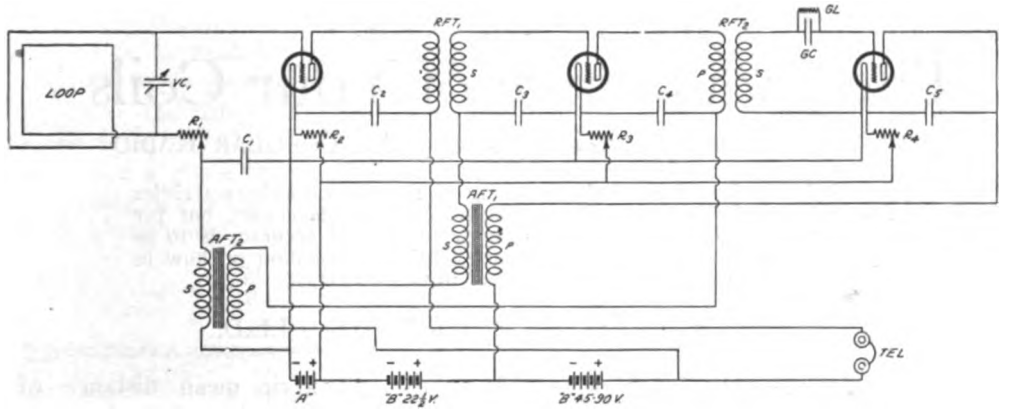


TRIPLE-COIL, HONEYCOMB REGENERATIVE CIRCUIT WITH TWO STAGES OF AMPLIFICATION

Cost of parts: Not more than $35.00.
Selectivity: Good.
Operation: Rather complicated.
Ease of construction: Not hard to make.
Approximate range: 1,000 miles on the low broadcasting and amateur wavelengths and 3,000 miles on the extreme high wavelengths.
Outstanding features: It may be made to cover all wavelengths by interchanging coils. The coils may be plugged into sockets at will, thus making the set into a high or low wave receptor which is regenerative.



THE GRIMES REFLEX CIRCUIT

Cost of parts: Not more than $40.00.
Selectivity: Excellent.
Operation: Extremely simple. Only one control for wavelength needed and one control for regeneration.
Ease of construction: This is a quite complicated circuit to follow out and to get in operation. There are a number of details that will give the beginner trouble when he first tries to make this set, but they can be overcome.
Approximate range: 500 miles (with loop antenna).
Outstanding features: No outdoor antenna is needed for DX reception. Simplicity of tuning. No crystal detector to bother with. The audio-frequency amplification is fed back to the next preceding tube in each stage.

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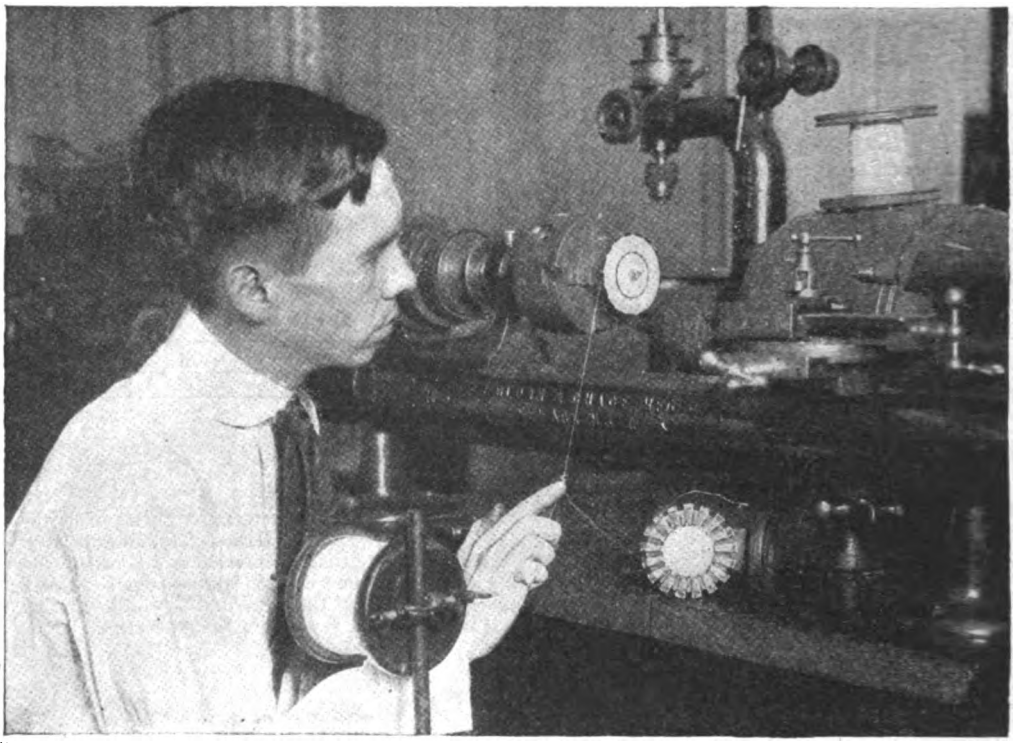

Kadel & Herbert

WINDING A SPIDERWEB COIL

For calculating the inductance for the various shaped coils, used in radio for reception, there are numerous formulas which are applicable to only one of the types or shapes of coils.

HOW TO CALCULATE

The Inductance of Your Coils

No. 6 of a series written especially for POPULAR RADIO

For this kind of mathematical foretelling of the electrical characteristics of coils, a number of standard formulas have been developed, but for a given type of coil a given formula must be used, if accuracy is to be attained. Some interesting formulas and helpful information on how to use them are brought out in this article.

By SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

THE expression given by Maxwell for the inductance of any compactly wound coil whose diameter is considerably greater than its width, is the following:

$$L = 4\pi n^2 r \left(\text{Log}_e \frac{8r}{R} - 2 \right)$$

Where r = the mean radius of the coil, n = the number of turns of wire, R = the geometric mean distance of the points in the section of its winding. R = one-quarter of the width and depth of the wound channel, added together.*

In applying this formula it is neces-

*This is sufficiently accurate for ordinary purposes. Thus, suppose the width was half an inch and the depth a quarter of an inch, the value of R would be a quarter of three-quarters, or three-sixteenths of an inch.

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sary to remember that the numerator of the fraction inside the brackets, whose natural logarithm is to be taken, must be decidedly bigger than the denominator—at least ten times greater—otherwise the 2 cannot be subtracted from it without causing error or even absurdity. For $\log_e 10 = 2.3$, and the balance is dangerously small, even then. It is necessary, therefore, that the radius r be itself at least double or treble the greatest sectional dimension, for then the margin is adequate and the formula applicable.

A much more elaborate expression to cover any case, is given by Maxwell, and simpler ones have now been invented and may be cited in due course.

Meanwhile we may examine the above expression to see when it is a maximum for a given length of wire. It is plain that the length of wire wound on the coil will be the number of turns multiplied by the average length of a turn, namely $2\pi r$; or $l = 2\pi n r$. So the expression is:

$$L = 2 n l \left(\log \frac{8r}{R} - 2\right)$$

Having decided on the *shape* of the section or channel for the winding (say square), it is plain that R varies with its linear dimensions, and that therefore, n varies as R^2. It also varies inversely as r, for a given length of wire. Putting these things together, it follows that L is a maximum when

$$\log \frac{8r}{R} = 3\frac{1}{2}$$

and that accordingly the maximum value of L is 3 n l, which is the same as $6\pi n^2 r$.

We will return to this extremely simple expression for maximum inductance, $L = 3 n l$, shortly. If T is the thickness of the covered wire, and b is the side of the square in which it is wound, it is obvious that

$$n T^2 = b^2$$

Hence the maximum self-inductance is

$$L = \frac{6\pi r b^4}{T^4}$$

But the condition

$$\log \frac{8r}{R} = 3\frac{1}{2}$$

gives us

$$\frac{8r}{R} = e^{3\frac{1}{2}} = \sqrt{e^7} = \sqrt{(1096 \cdot 6)} = 33 \cdot 11$$

Or

$$\frac{r}{R} = 4.14$$

Whence, for a square section,

$$r = 4.14 \times \cdot 45 b$$
$$= 1 \cdot 863 b$$

The outside diameter is

$$2r + b = 4 \cdot 726 b$$

The inside diameter is

$$2r - b = 2 \cdot 726 b;$$

so that

$$D = 1 \cdot 734 d.$$

Now since $r = 1 \cdot 863 b$,
the maximum L may be written

$$\frac{6\pi \times 1 \cdot 863 \times b^5}{T^4}$$
$$= \frac{35 \cdot 1 b^5}{T^4}$$

The Preceding Articles of This Series by Sir Oliver Lodge—

1. How to Get the Greatest Efficiency out of Your Radio Circuits ..... *March*, 1923
2. How to Get the Maximum Inductance in Your Coils..... *May*, 1923
3. The Ratio in Size Between Your Antenna and Your Coil..... *July*, 1923
4. Helpful Formulas for Designing Your Coil..... *September*, 1923
5. Practical Hints for Coil Calculation..... *October*, 1923

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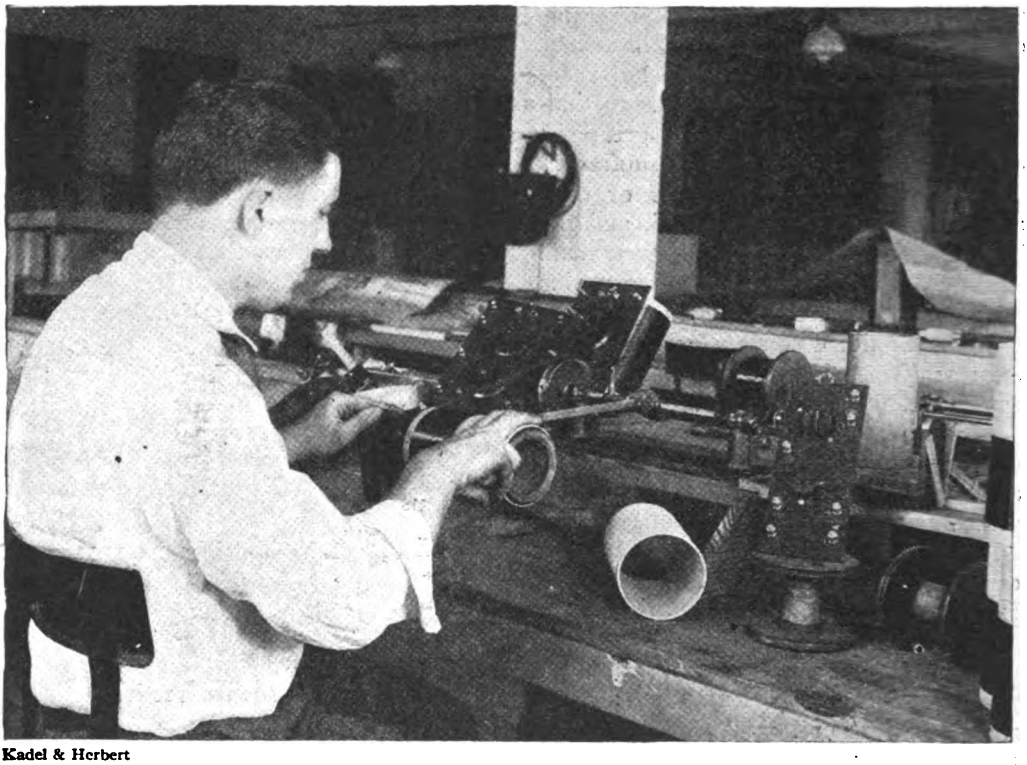

Kadel & Herbert

WINDING AN ORDINARY SOLENOID COIL ON A LATHE

This is the most used type of coil in this country, for reception below 600 meters. The wire is usually wound on a composition tube and the turns run in a single layer, each turn lying beside the preceding turn.

or, using n_1 to express the number of turns per unit breadth,

$$L_m = 35 \cdot 1 n_1^4 b^5 *$$

Given the inductance required, and also the thickness of covered wire to be used, this determines b the size of the groove which is to be filled with wire.

$$b = \tfrac{1}{2} \sqrt[5]{L T^4}.$$

We know that the mean radius of the bobbin is $r = 1{\cdot}863\, b$, so the external diameter of the bobbin is $\frac{14}{8}$ b, while the internal diameter is $\frac{8}{8}$ b.

(More exactly, of course, the fifth root of 35·1 is not 2 but 2·04.)

Example:

Let the inductance required be 1,600 meters, and the thickness of covered wire half a millimeter. Then

$$L T^4 = \frac{1{,}600{,}000}{16} = 10^5$$

So approximately we get for breadth and depth of section, $b = \frac{10}{2 \cdot 40} = 4{\cdot}9$ millimeters.

For external diameter D = 23 millimeters.

For internal diameter d = 13 millimeters.

For mean radius $r = 1{\cdot}863\, b = 9{\cdot}13$ millimeters.

For number of turns

$$n = \frac{b^2}{T^2} = 96$$

For length of wire

$$l = 2 \pi n r = 5{,}520 \text{ millimeters}$$
$$= 5\tfrac{1}{2} \text{ meters}$$

*Only simple arithmetic is needed to convert this into the formula previously given: $66 \cdot 6\ L = D^5\ T^4$.

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If we check this by reckoning back to the inductance as 3 n l, an expression as obtained a few paragraphs above, we shall find it about right. This extremely simple expression, 3 n l, for maximum inductance, when the proper conditions are satisfied, is perhaps not of much use for predetermination, but it is handy for checking. It is worth considering, moreover, whether its simplicity does not make it useful even for the beginning of predetermination; and this we will do in another article.

If we need to know the inductance, or the resistance, or any other feature, of a coil extremely accurately we must determine it by direct experiment. Its estimated value can only be a first approximation, unless excessive precautions are taken and an elaborate calculation made.

But it may be asked, "Is no notice to be taken of the thickness of the uncovered wire—the conductor itself?" We always seem to attend to the thickness of the covered wire instead of to the bare copper. Well, there is a small correction to represent the concentration of the current in the core of the wire sheath. It takes the form of a small addition to the inductance, and Maxwell's complete expression for a ring-shaped compactly wound coil of large diameter is not merely what is quoted above, but has an additional term, so that it may be re-written thus:

$$L = 4\pi n^2 r \left\{ \log_e \frac{8r}{R} - 2 + \frac{1}{n}\left(\log_e \frac{T}{t} + \cdot 12\right)\right\}$$

where $\frac{T}{t}$ means the ratio of the thicknesses of the covered to the bare wire.

The fact that the logarithm of this ratio has to be divided by the number of turns, before using it as a correction inside the bracket, shows that it is but a small correction, even when the covering of the wire *is* thick.

We will only attend to it for a coil shaped so as to give maximum inductance, and in that case the formula becomes

$$L = 3\,n\,l + 2l\left(\log_e \frac{T}{t} + \cdot 12\right)$$

Or practically

$$\frac{L}{l} = 3\,n + \log\left(\frac{T}{t}\right)^2$$

So for a coil of many turns the correction is small, but it always tends in the direction of increase.

Taking an extreme case, in which the covering is so thick that T = 10 t, then for a coil of 100 turns the factor with which to multiply l is not 300 but 305, when the correction is applied

Coils of Other Shapes

For the calculation of the inductance of coils in general several formulas have been elaborated by the mathematicians. Some of these are appropriate for one shape, some for another.

For compact coils, of which the dimensions of the wound channel are small compared with the diameter of the whole coil, the fundamental formula of Clerk Maxwell is probably the best. But for elongated or spread out coils—those in the shape of a long cylinder, for instance—a quite different formula is more serviceable. The Maxwellian one would then be unwieldy, and in its simple form altogether inapplicable.

For elongated or cylindrical coils an expression was worked out by Cohen.*

It applies to a single-layer coil whose length is not less than four times its diameter, and runs thus:

$$L = 4\pi^2 n_1^2 r^2 \left(\frac{2r^2 + b^2}{\sqrt{(4r^2 + b^2)}} - \frac{8r}{3\pi}\right)$$

where b is the length of the helix (i.e., the breadth of the coil), r its radius, and n, the number of turns per unit length.

Neglecting r^4/b^4, that is, taking the ratio r: b as moderately small, this can be simplified down to the following very handy formula, with n_1 b replaced

*See the *Bulletin of the Bureau of Standards, U. S. A.*, Volume 4, page 385, for 1907-8.

*See also The Appendix to Professor Pierce's "Principles of Wireless Telegraphy," page 341.

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Bureau of Standards

A U. S. STANDARD OF INDUCTANCE

This is one of the standard inductance coils, used by the Bureau of Standards at Washington, D. C., for actual inductance measurements of other coils. The standards are matched up with other coils of unknown inductance in a bridge-circuit and their inductance is thus determined.

by n the total number of turns of wire,

$$\frac{L = 4\pi^2 n^2 r^2}{b}\left(1 - \frac{8}{3\pi} \cdot \frac{r}{b}\right)$$

Or in other words,

$$L = \frac{\text{square of total length of wire}}{\text{length of coil}}\left(1 - \frac{8}{3\pi} \cdot \frac{r}{b}\right)$$

where the correction factor in brackets is of less and less importance as the helix is longer and narrower.

Example: Take a coil 1 meter long, wound with covered wire 1 millimeter thick, the diameter of the coil being 20 centimeters, so that $\frac{r}{b} = \frac{1}{10}$. The number of turns will be 1,000, and the total length of wire 20,000 π centimeters. So

$$L = \frac{(\text{Length of wire})^2}{\text{length of coil}}\left(1 - \frac{8}{3\pi}\frac{r}{b}\right)$$

$$= \frac{4 \times 10^8 \pi^2}{100}\left(1 - \frac{8}{30\pi}\right)$$

$$= 36.6 \times 10^6 \text{ centimeters} = 366 \text{ kilometers.}$$

If the coil is only fairly long, and the ratio of its radius to its length be called x, then a few additional correcting terms, due to Dr. A. Russell, can be added, so that it becomes:

$$L = \frac{\text{square of total length of wire}}{\text{length of coil}}$$

$$\left(1 - \frac{8x}{3\pi} + \tfrac{1}{2}x^2 - \tfrac{1}{4}x^4\right)$$

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All expressions for L inevitably involve the square of the number of turns and the linear dimensions of the coil, so that the answer comes out as a length. All the rest of the formula consists of ratios of similar quantities, that is to say, of mere numbers. All such formulas, provided there is no error, will give the right order of magnitude for the inductance; on the assumption, of course, that the core is air, and not iron. But there will usually be some corrections to apply if accuracy is wanted. More accurate formulas are given in Eccles' Handbook to Wireless; but usually the accurate value is best obtained by experiment.

Disc Coil

The value of L for a disc coil of large aperture can be reckoned from Maxwell's formula.

Or we may re-write it in terms of external and internal diameter of the disc coil thus:

$$L = \pi n^2 (D+d) \left\{ \log_e \left(16 \frac{D+d}{D-d} \right) - 2 \right\}$$

Let us apply this to a disc spiral of external diameter 6 inches and internal diameter 2 inches.

$$L = 8 \pi n^2 (\log_e 32 - 2) \text{ inches}$$

Or if there are 10 turns in the spiral,

$$L = 2{,}500 \times 1{\cdot}466 = 3{,}700 \text{ inches}$$

or about 100 yards.

It is remarkable how nearly the simple expression 3 n l happens to agree with this. But it won't apply at all to the case of a long cylindrical coil or solenoid. It would give a result much too big for such a coil; though it is nearly right for a disc.

A long coil may be convenient for sliding contact purposes, but it does not give maximum induction. A disc coil on the other hand is not usually so far away; and indeed a properly shaped coil can be built up of disc coils.

The close addition of one disc coil to another similar one will practically quadruple the inductance, and therefore double the wavelength to be dealt with. A third coil will approximately treble the wavelength, the antenna or condenser capacity remaining the same.

Kadel & Herbert

A group of Arapahoe Indians from Wyoming, camping in New York while on their way to England, get their introduction to radio.

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From a photograph made for POPULAR RADIO

THE ORIGINATOR OF THE FAMOUS SHORT-WAVE RECEIVER

Paul F. Godley, one of the most capable radio experts in the world, demonstrates a new method for picking up radio signals.

Receiving Without Antennas

How to use the ordinary regenerative set efficiently and economically without an outside antenna, without expensive radio-frequency amplifiers and without a complicated circuit

By PAUL GODLEY

THERE is an increasing desire on the part of radio folks and would-be fans to receive without using an antenna. The usual excuse is that someone in the household is in fear of the effects of lightning when any overhead conductors run to the home.

Fears such as these are groundless. There is no more danger from an antenna than from electric light and telephone service, which have running to them overhead conductors elevated to practically the same extent that an antenna needs to be elevated. The mystery which is wrapped up in radio seems to carry with it, for many, some of this unfounded fear. Thus it is we find experimenters, writers, and manufacturers trying to cater to this demand.

Circuits of one sort or another have been devised which enable broadcast reception without the use of an antenna. Mainly these have been comprised of multi-stage amplifiers of the radio-frequency type; so far as the writer knows, no general attempts have been

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made to take advantage of the inherent sensitivity of regenerative circuits in conjunction with "antenna-less" outfits.

In passing, two interesting facts might be observed. (1) The cheapest and most effective form of radio amplification which has ever been devised for use in conjunction with an antenna-less radio receiver may be constructed at a cost of a few dollars. In effect it will equal or surpass three stages of the best radio-frequency amplification which the writer has ever seen. It is comprised of an average-sized antenna and a good earth connection.

(2) As compared to hazards involved by telephone and electric light connection due to lightning or other cause, the lightning hazard of an antenna is, at least, small.

Multi-stage radio-frequency units depend as a rule for excitation upon the energy collected by a loop antenna consisting of a few turns of wire on a square frame, two feet or so on a side, and almost invariably the circuits call for a ground connection. Upon trying circuits of this sort, it is immediately learned by the experimenter that if the ground connection is left off the strength of the received signal is materially weakened. From this it must be assumed that all of the energy which excites the outfit does not come to it through the loop antenna; that the ground connection in itself is in some manner acting as an antenna; that currents are being generated in the earth and fed up to the receiver through the ground connection.

It takes but a moment for even the uninitiated experimenter to prove to his own satisfaction that the currents generated in the loop antenna, such as that described briefly above, are small indeed as compared to those generated in an overhead antenna of average dimensions. In other words, the difference of potential which exists between the points A, and B, in the antenna circuit of Figure 1-A are quite large as compared to those differences in potential existing between points A, and B, in Figure 1-B. The ratio of those potentials will run somewhere in the neighborhood of one hundred to one. If the ground connection is run directly to

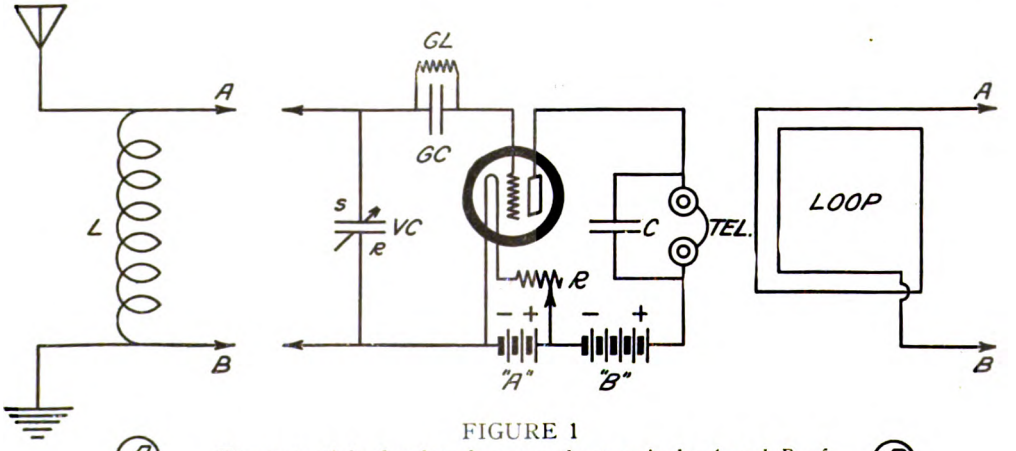

FIGURE 1

The potentials developed across the terminals A and B of coil L (shown at "A" in connection with an outdoor antenna) are of enormously greater amplitudes than those developed across A and B of the loop antenna (shown at "B"). If either of these two pick-up systems were used with the vacuum-tube detector circuit (shown in the middle of the diagram), scheme "A" would therefore be immeasurably better.

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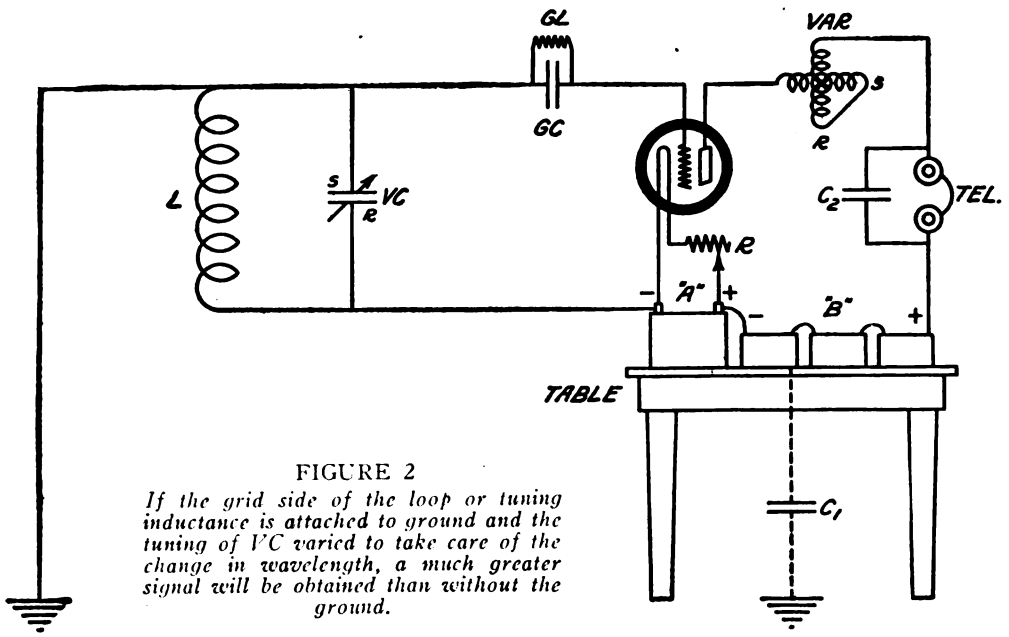

FIGURE 2

If the grid side of the loop or tuning inductance is attached to ground and the tuning of VC varied to take care of the change in wavelength, a much greater signal will be obtained than without the ground.

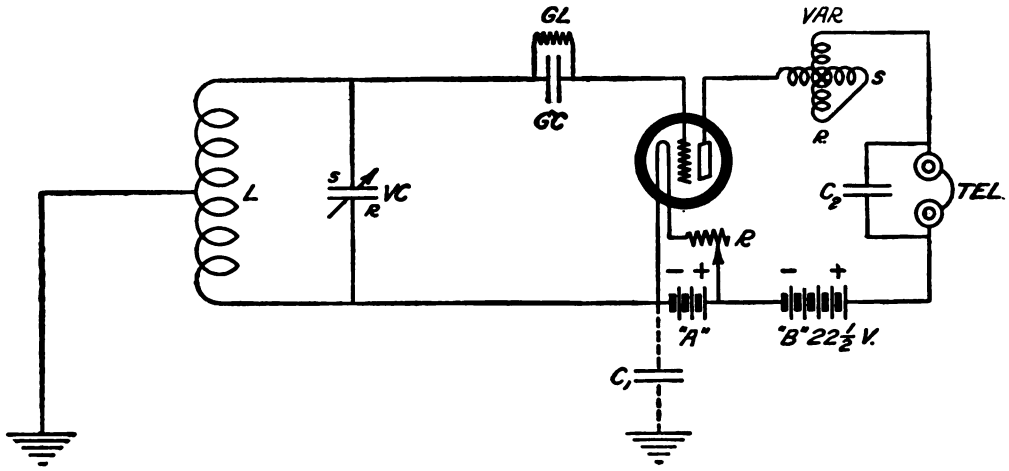

FIGURE 3

A still greater signal may be obtained by this method of grounding in which the ground is taken off somewhere in the middle of the loop or tuning inductance.

the grid of the vacuum tube (as shown in Figure 2) and if proper compensation is made in the tuning element of Figure 2 so as to allow for the change in wavelength which results, surprisingly large values of signal will be fed into the outfit as compared to those fed into it by the loop alone. The ratio of the signal potentials picked up on the average ground connection, as compared to those picked up by the average antenna, is about twenty to one in favor of the antenna. This ratio will vary a great deal, however, depending upon the type of ground connection. Where the ground connection is a long one, the energy picked up will be *greater;* if the ground connection is a

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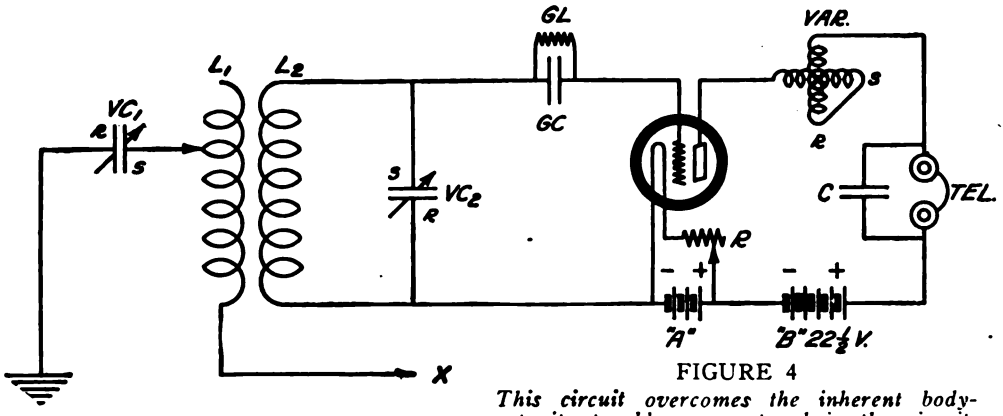

FIGURE 4

This circuit overcomes the inherent body-capacity troubles encountered in the circuits of Figures 2 and 3.

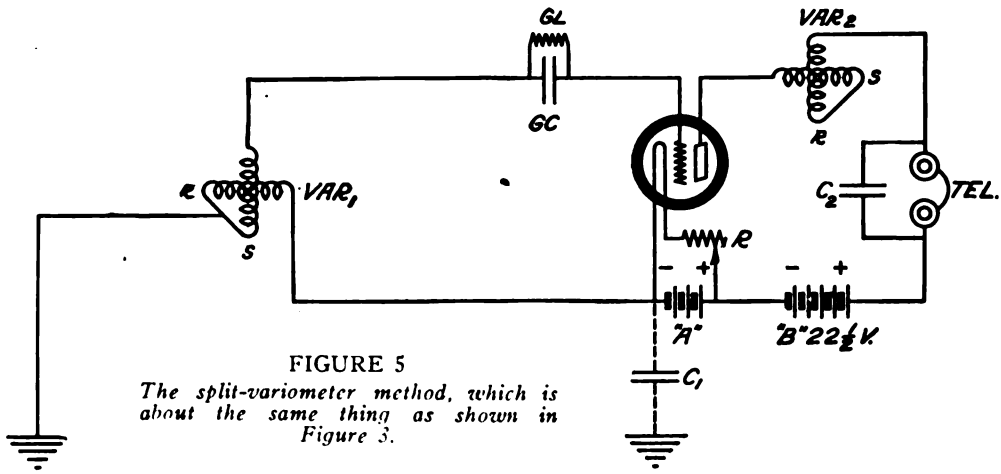

FIGURE 5

The split-variometer method, which is about the same thing as shown in Figure 3.

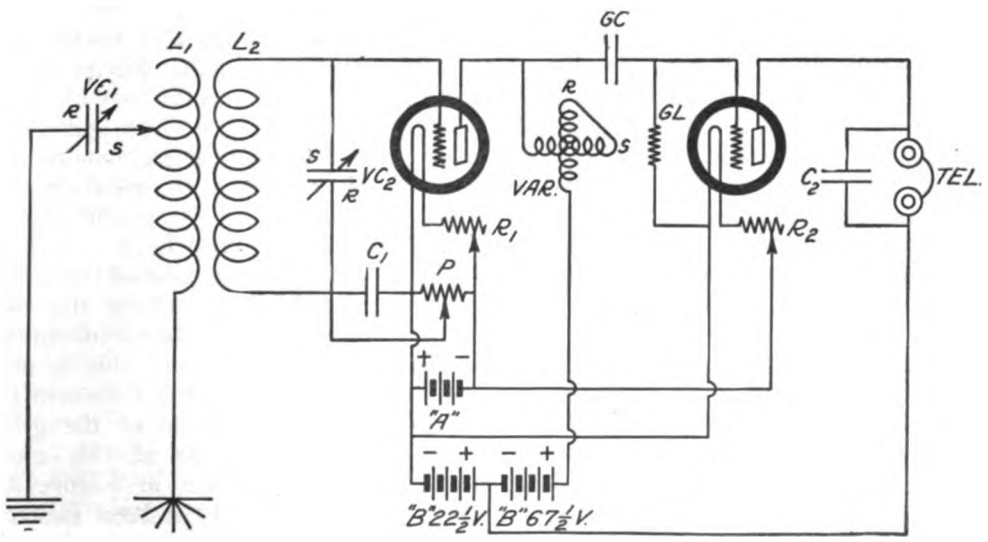

FIGURE 6

One stage of tuned, regenerative, radio-frequency amplification added to Figure 4.

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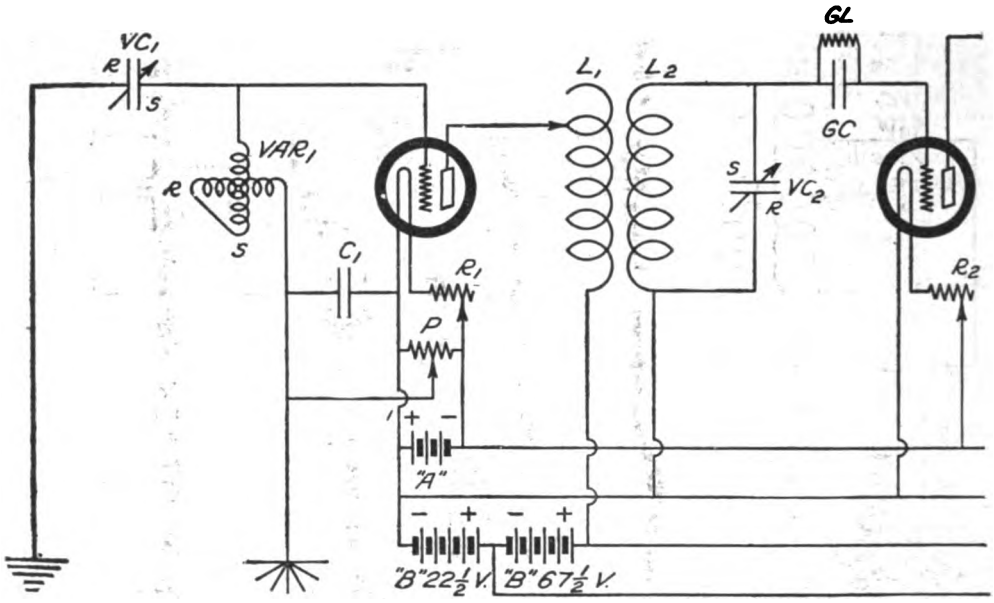

FIGURE 7

The best circuit arrangement of all to use. This is a standard three-circuit regenerative receiver, with the tuned ground circuit, one stage of radio-frequency amplification and two stages of audio-frequency amplification.

short one, it will be *less*. In the average home, however, this ratio of approximately twenty to one will hold true.

Connecting the ground to the grid of the vacuum tube is *not* desirable, however, for the reason that the size of the capacity C-1, is large. (This capacity C-1, is formed by the receiver and its battery which go to make up one plate of a condenser, and the ground which forms the other plate. The insulating material, air, or whatever it may be, between the receiver and the earth, forms the dielectric. Its value will, of course, vary, depending upon the location of the receiver with respect to the earth.)

A better method of connection is that shown in Figure 3, where a tap is taken out of the center of the grid inductance and grounded. This, however, has not completely eliminated the difficulty of the shunt capacity; furthermore, both the methods of Figure 2 and Figure 3 place the filament circuit of the receiver at a potential considerably above earth potential, which results in serious difficulties as soon as one attempts to tune the outfit, as the operator's body in approaching the receiver will alter the value of the capacity C-1, in either case, with the usual baffling result.

The circuit shown in Figure 4 overcomes these difficulties and results in the same signal strength. Figure 4 is easily arranged in conjunction with any standard three-circuit receiver and may be set up without any great amount of difficulty when using a single-circuit receiver (merely by supplying and coupling an extra inductance L-1).

Figure 5 indicates a method of utilizing the earth pick-up where the receiver is comprised of two variometers, one in the grid circuit and one in the plate circuit. In this case, the earth is connected to the mid-point of the grid variometer. On account of this connection and that shown in Figure 3, circuits of this type have been classed as "split circuits," although reference to Figure 3 will indicate that there is noth-

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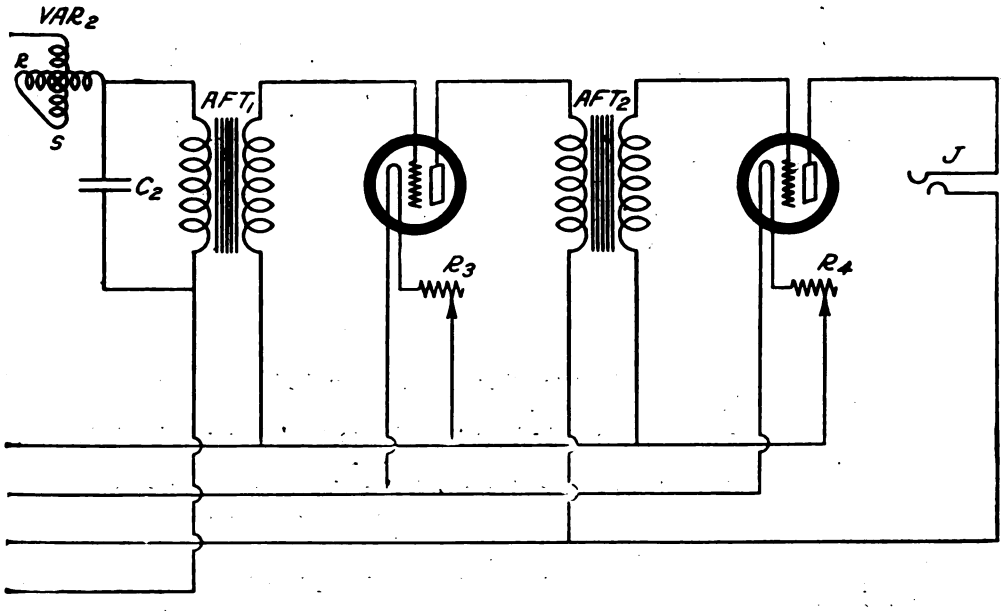

ing particularly novel about the arrangement.

Figure 6 shows the circuit of Figure 4 except that the vacuum tube coupled directly to the pick-up connection (ground) acts as a tuned regenerative, radio-frequency amplifier. Difficulty will be had with this circuit due to its persistent tendency toward oscillation unless some method is used to control the oscillations. A potentiometer may be connected as shown in Figure 6 so as to throw *positive* potentials upon the grid of the radio amplifier. Or resistance may be placed in the grid circuit of the radio-frequency amplifier tube, but, this broadens the tuning to a marked degree unless the circuits are on the verge of oscillation at all times, and is, for this reason, undesirable. It is far better to use the potentiometer method shown or to regulate the amount of potential fed to the plate circuit of the radio-frequency tube.

Figure 7 is perhaps the best circuit of all; in this a single stage of tuned-radio-frequency amplification is employed. Here a standard three-circuit, regenerative receiver is connected with the radio-frequency amplifier as shown. The variable coupling between the output circuit of the radio-frequency amplifier and the input circuit of the detector in the regenerative receiver will provide complete control over the tendency toward oscillation in the radio-frequency circuit. Tuning the pick-up circuit may best be accomplished by utilization of a variable condenser as shown, or by the substitution of a variometer for the inductance L, in this circuit.

Using the combination shown, it is usually possible, either in the city or the country, to pick up signal strength of sufficient order to operate a loud-speaker satisfactorily from a two-stage amplifier at distances of twenty-five or thirty miles from the broadcasting stations. This is particularly true when the tuned-radio-frequency unit is used.

Those who are in the habit of carrying radio receivers to remote places will find it easy indeed by substituting a wire fence for the ground connection, to pick up distant stations. Railway tracks, exposed water lines, wires thrown into the bed of a brook or small stream, and other similar connections have been used with remarkable success in just this way.

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HINTS FOR
Learning the Code

By EDWARD R. LEIGHT

1. Do not let your thoughts divert to other things. Form the habit of concentrating. It is the basis of all success in learning the code.

2. WHEN you memorize the code, make it an "intelligence test" by mastering it in a given length of time.

3. ONCE you have learned the code and you "miss" a character, do not stop and try to think of it. It will come to you the next time. If the group is a word, the character can be filled in; otherwise you have lost the entire group. The habit of holding on to characters, temporarily forgotten, retards the progress in speed.

4. THE beginner who insists on counting the dots and dashes invariably confuses one character with another, particularly when trying to copy speed.

5. Go over the characters in your mind in between times; not by so many dots and dashes but by the sound. For instance Y is—dah-dit-dah-dah.

6. EACH code character is a musical sound. Memorize it in that way. If you must begin by counting the dots and dashes, do so. But save time and acquire speed by reverting to the sound method as soon as possible.

7. Do not attempt to put a character down before it has been completed. Read ahead and write at least one or two characters behind the key.

8. IN copying well behind the key there is ample time to determine doubtful characters before you come to them, to space the groups or words properly and to make a neat copy.

9. THE habit of writing two or more characters behind the sender comes from retaining groups or words in the mind; that is, by having someone send press, word at a time, which must not be written down but connected in the mind and called off as completed. Begin with short words, sent slowly, and increase in length and gradually in speed.

10. THE habit of trying to guess the words and attempting to write them down before they have been completed is a bad one. In many instances the word turns out to be other than that expected and the result is that you become disconcerted and lose the rest of the message.

11. MAKE the characters legible. I's and E's, T's and L's and K's and H's, for instance, should not resemble each other. Dot the I's and J's, cross the T's and distinguish M's, N's and U's from each other.

12. WHEN you send, round out the characters properly. Make the dashes of equal length, the dots in proportion, and evenly and equally spaced.

13. DON'T try to send fast at first. Learn to form the characters correctly; then send slowly and work up in speed as you grow in proficiency.

14. AVOID jerky sending. This is generally the result of holding the muscles stiff. Let the forearm rest on the table; let the muscles relax and put the movement in the wrist. This rests the arm and makes it easier to form the characters correctly.

15. To send fast is one thing; to send fast correctly is another. Become known for having a good "fist" by first practicing slowly and carefully.

16. THE habit of letting the fingers come in contact with the metal of the key while sending is a bad one. It will eventually result in a shock.

17. WHEN you make an error in transmission make two interrogation marks, instead of a series of dots, and then begin the word anew.

18. SEPARATE the heading of the message from its body by a break or double dash; likewise the body and signature.

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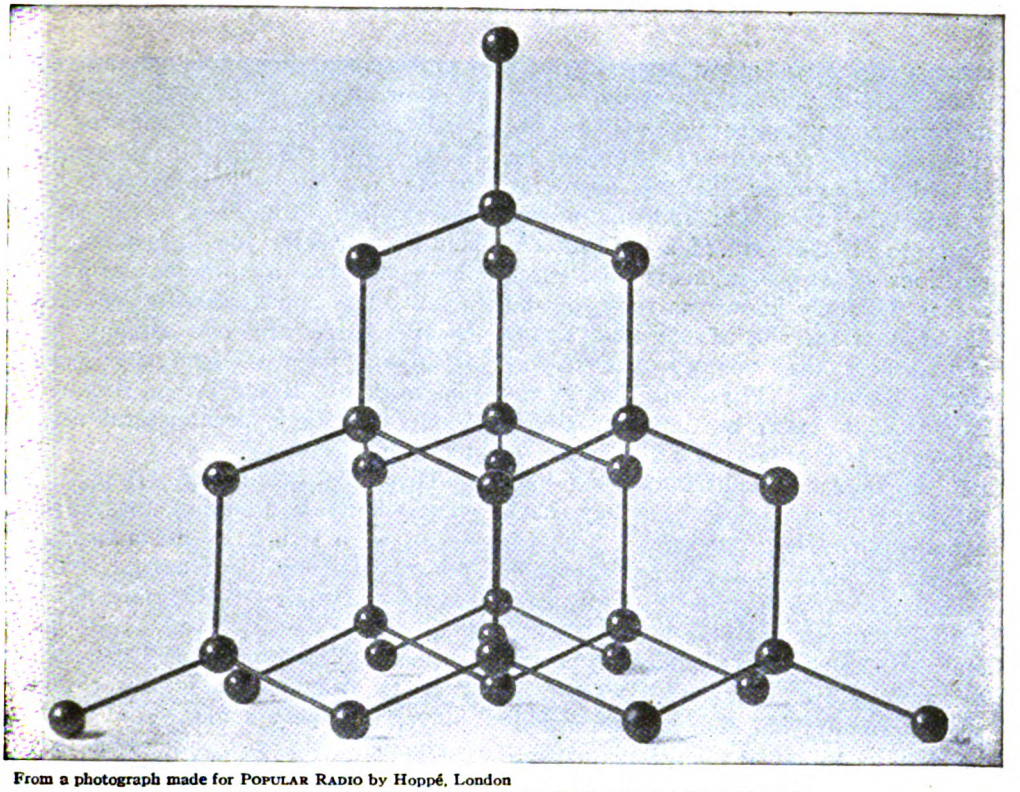

From a photograph made for POPULAR RADIO by Hoppé, London

HOW THE ATOMS OF CARBON ARE ARRANGED
INSIDE OF A CRYSTAL OF DIAMOND

As they would look if they were magnified several million times. The model was made by Sir William H. Bragg.

The Crystal Houses that Atoms Build

By WALDEMAR KAEMPFFERT

PICK up a brick. How heavy, how solid and substantial it seems. Look at the heavens above you—at the distant moon, at the still more distant stars. How empty seems the sky for all the myriad twinkling suns and planets in that vast black canopy. Yet the brick in your hand is relatively no more solid than the immense expanse above you. If you could but magnify it to the dimensions of the solar system the atoms of the brick would be millions of miles apart.

Any solid, a chair, a table, the flesh of your body is emptier than it seems—an aggregation of countless atoms, but atoms separated from one another by distances that are comparatively as awe-inspiring as those that greet the astronomer's eye. Hundreds of comets have swept through space without colliding with planets or suns, and a comet far smaller than an atom might theoretically swim through a seemingly dense brick just as readily.

Medieval churchmen were given to

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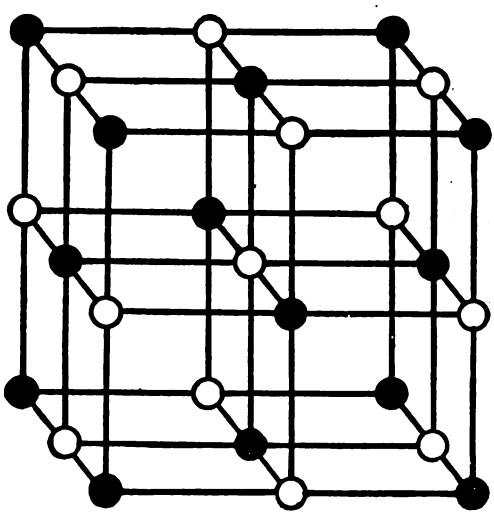
speculating how many angels could stand on the point of a needle. The modern conception of a solid's spaciousness of structure is not to be classed with similar idle vaporings. It would take a million million million atoms to fill the head of a pin, but the positions of atoms in many substances are as definitely known as those of the blocks of stone and of the steel beams and girders that compose the Woolworth Building. Physicists and chemists used to *guess* at the internal arrangement of atoms in an element or its compounds. Now they *know* how they are grouped because they have actually seen the groupings.

Two brilliant, painstaking, thorough scientists discovered a method of making the infinitely small atom tell the story of the part that it plays in chemical architecture. They have worked in such harmony that the one can hardly be mentioned alone. This follows not only because they are father and son, but because they have experimented together, reasoned together and written together about their investigations. Bragg is their name. Professor Sir William H. Bragg is the father; Professor W. L. Bragg is the son. Talk to the son about atoms and he will refer you to his father; talk about them to Sir William, and he will refer you to his son. When the Nobel prize for physics was awarded a few years ago it was divided between them. There are two Braggs in the flesh, but scientists generally speak of the work of "Bragg" when they discuss atoms and their architectural arrangement in matter.



THE SKELETON OF COMMON SALT

The black spots represent atoms of sodium and the white spots atoms of chlorine, as they are arranged inside a crystal of sodium chloride which is the chemist's name for common salt.

These extraordinary Braggs, like generations of scientists that preceded them, were struck by the amazing and obvious uniformity of crystal structure. Always crystals of the same composition are alike so far as the angles formed by corresponding faces are concerned. Diamonds may differ in size, but not in these angles. And so sugar, common table salt, and hundreds of other crystals, invariably present the same angular uniformity. It was evident long ago that a crystal must be built somewhat like a skyscraper and that some unit-pattern or floor-plan must be repeated over and over again.

Now it happens that most of the solids that we know are crystalline in nature. Hence the man who can make a crystal reveal the secret of its structure so that we can draw a plan of it as we can of a house, must go far toward answering such age-old questions: What is matter? Why is iron iron and gold gold? Why is an element what it is and not something else? What holds a lump of matter together? Why is it different from a liquid or a gas? Why doesn't it fly apart?

While it was apparent that a crystal must be built according to some definite unit-pattern or floor-plan, there were long only shrewd guesses as to what the unit-pattern or floor-plan must be. The trouble was that no microscope could possibly be invented which would magnify the infinitely small atoms and show

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From a photograph by Hoppé, London

AN EXPLORER IN THE REALMS OF THE ATOM

Sir William H. Bragg (together with his son, Prof. W. L. Bragg) has supplied most of our knowledge of how the atoms inside of crystals are put together. The instrument shown above is the identical X-ray spectrometer with which were made many of Sir William's explorations into the realm of these tiniest of dimensions.

us exactly how they are grouped. Lenses are themselves composed of atoms. To see atoms in a crystal the lenses themselves would have to become granular or atomic.

In 1912, Laue, a Swiss physicist, made this startling suggestion: Turn the X rays on crystals. Two discoveries might be made. In the first place, the true nature of X rays might be revealed, about which there was no unanimity of opinion at that time. In the second place the atomic structure of a given crystal might be disclosed.

To understand why Laue made this suggestion and carried it out himself we must grasp the nature of light and of the many other waves that undulate

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General Electric

A NOVEL DEVICE FOR STUDYING ATOMS
BY X-RAY PHOTOGRAPHY

An American student of crystals, Dr. A. W. Hull of Schenectady, and the apparatus developed by him for examining how the atoms are arranged inside the fragments of a crystalline powder. Strips of photographic film inside the quarter-round boxes on the top of the apparatus permit the making of four X-ray crystal photographs simultaneously.

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through the ether. That energy is transmitted in waves every radio amateur knows. His waves are like light waves, only longer—so long, in fact, that his eyes cannot see them.

When we say that we "see" a light we mean that our eyes have been affected by waves of a certain size and frequency. A musical note may be deep or shrill; it has what we call a certain "pitch." Light has its pitches, too; only we call them "colors" in the vernacular, while the scientist speaks of wavelengths, just as amateurs do in radio parlance. A radio set can be tuned to receive music and speech on a certain wavelength band. When we look at the world around us through a piece of red glass we have tuned in to red; we have excluded all other wavelengths of light. Like any radio set the eye has its limitations so far as this tuning process is concerned. Our visible wavelength band extends from deep red to deep violet. The red waves are the longest which we can see or to which we can tune in, and the violet the shortest. An ordinary camera is a far better receiver of light waves than our eyes. It can photograph the invisible. It can "see" or be attuned to waves that are much shorter than those that lie beyond the violet end of the spectrum—waves that are called ultra-violet.

The only difference between radio waves and light waves is one of wavelength. A radio wave may measure twenty miles from crest to crest when it is sent half around the world by some powerful trans-oceanic station. Visible light waves have an average wavelength of only one fifty-thousandth of an inch. Still shorter are the X rays.

It follows that an ordinary light wave is huge compared with an X-ray wave. That was one reason why scientists were at first not sure whether or not X rays should be classed as light waves. For example, they could not reflect X rays Now we know the reason. Mirrors reflect light because they are very smooth surfaces. A rough surface scarcely reflects light. The smoothest surface that human skill could produce is rougher than sandpaper to the X rays. For this reason X rays cannot be reflected by any smooth man-made surface. But the atoms of crystals (not the actual surfaces) are so much finer than X rays that they can act as reflectors. Knowing this, Laue proposed that they be used as little mirrors. When a crystal of mica was broken and subjected to test a beautiful X-ray reflection was obtained. X rays were thus proved to be a finer kind of light.

At this point the Braggs appeared. Laue had a rather cumbrous apparatus which, however successful it was in enabling him to prove that X rays are light waves, was not simple or effective enough to penetrate deep into the heart of a crystal. That there was a regular arrangement of the atoms was clear, but the exact structure was not readily determined. The Braggs devised a simple instrument which they called an "X-ray spectrometer," and with it they tore aside the veil of mystery and conjecture in which the atoms had so long been shrouded.

They knew that they could never hope to see an atom; there was no way of magnifying it the necessary one hundred million times. But they could make it reflect X rays, and they could note the points of reflection and thus locate the atoms.

This can be made still clearer if we imagine that we had to study water waves by the action of corks thrown upon the ocean. The corks have no effect whatever on the large waves (the equivalent of ordinary light waves). But if the surface of the water is disturbed only by the smallest perceptible ripples (the equivalent of X rays), they have a very marked effect. As the fine ripples strike a cork they are broken; there are ripple reflections and scatterings. If the corks were invisible a clear-headed, straight-thinking scientist

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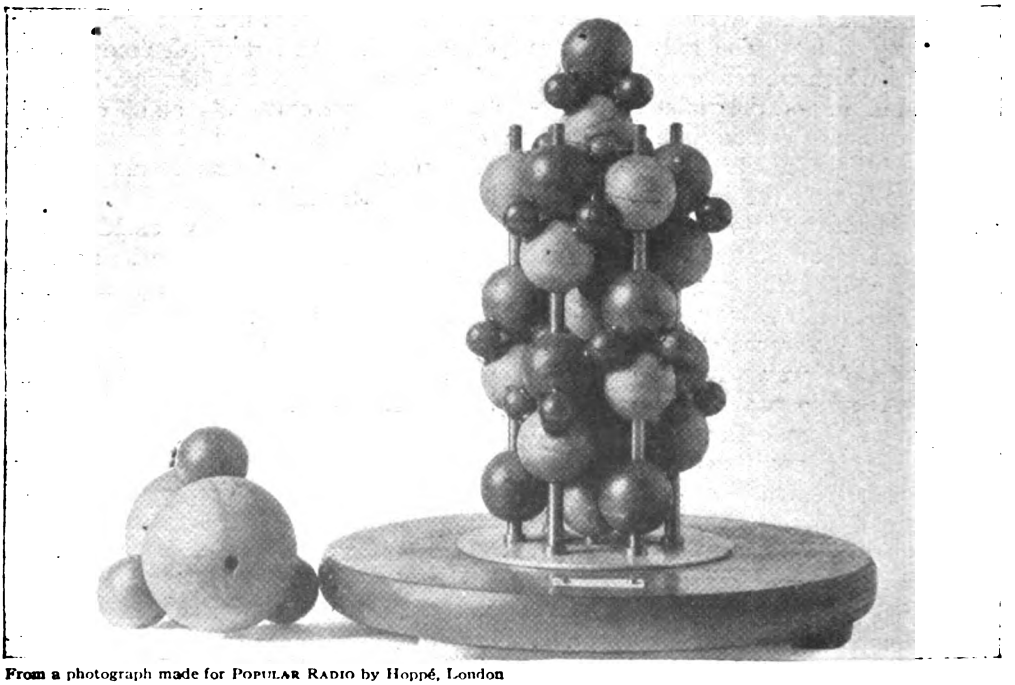
could form a very good picture of their size and spacing simply by watching the way in which the ripples were broken.

So the Braggs turn the X rays on a crystal and note with their spectrometer the manner in which they are scattered by the invisible atoms. A photograph is taken. To one who knows nothing about light, X rays, wave motion, and atoms, it is meaningless—a blur of lines. To the Braggs and to scientists who have repeated their experiments it is as clear as the blueprint of a complicated machine is to an engineer.

What is it that is so startling? You have seen a field of corn planted in regular rows. Look down one row and you see an almost endless line of stalks. Looks down another and you see a second line. In whichever direction you look there is this regular, precise array. So the Braggs; in a sense, look down the avenues of a crystal from end to end. They do more than look; they actually measure the intervals between the atoms. Mind you, these atoms are so small that billions of them are clustered in the smallest visible speck of dust. Yet these two indefatigable men have measured the spacings with such accuracy that the error cannot be more than one in one thousand.

The stalks in a corn field have been regularly planted in two dimensions only—according to the length and breadth of the field. Atoms in a crystal are located in avenues that spread out in three directions. This makes it possible for them to distribute themselves in many very regular ways, but nature seems to content herself with not more than four or five.



From a photograph made for POPULAR RADIO by Hoppé, London

A STILL LIFE STUDY OF ALUMINUM AND OXYGEN ATOMS

How the atoms of aluminum (represented by the large balls at the left) and of oxygen (the small balls) are arranged inside the crystal of a gem ruby. This, like the diamond model reproduced on the first page of this article, is from the collection of crystal models prepared by Sir William H. Bragg.

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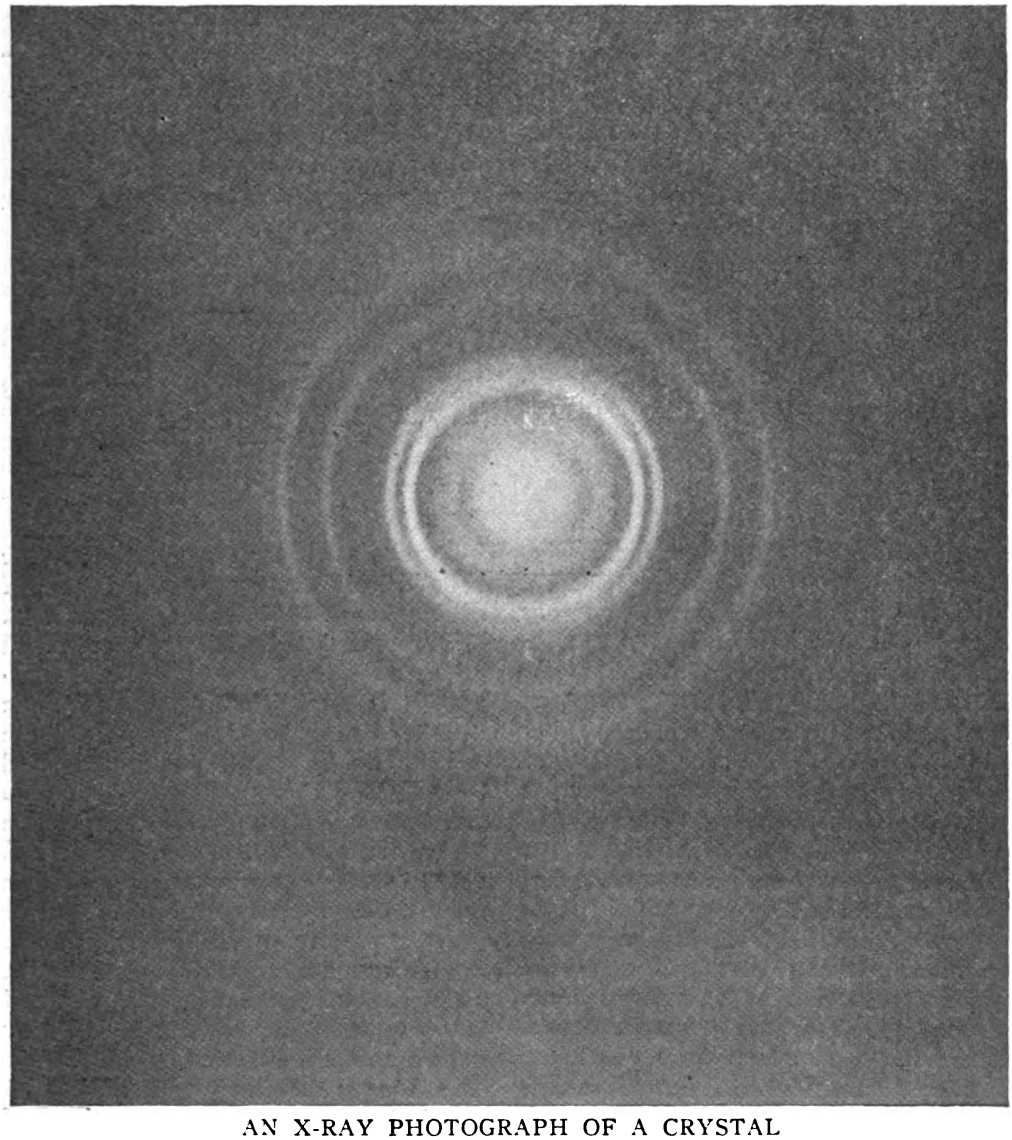

AN X-RAY PHOTOGRAPH OF A CRYSTAL

This ring pattern was produced by the bending of X-rays on passing through a thin sheet of aluminum. From the relative diameters of the different rings it is possible to calculate the arrangement and distance of separation of the atoms in the tiny invisible crystals of aluminum.

Take the diamond, for example. Each atom has four neighbors regularly disposed about it. A group is formed which has the shape of a tetrahedron. Why is a diamond hard? Because of this very tetrahedron arrangement of its atoms. A diamond is pure carbon. So is graphite. Why is graphite black and greasy to the touch and the diamond brilliantly transparent and hard? Graphite atoms are arranged in hexagonal columns which split with the greatest ease into thin leaves that slide easily on one another. It is this slipperiness of the leaves that makes graphite such a good lubricant. As for the difference between the diamond and graphite in color and brilliancy—that is due to the

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internal structure of the atom itself.

Potassium chloride is a familiar chemical compound. As its name indicates, it is composed of potassium and chlorine. The Braggs have shown that in a crystal of potassium chloride each potassium atom is surrounded by six chlorine atoms and each chlorine atom by six potassium atoms. In the ruby the unit consists of a pair of aluminum atoms surrounded symmetrically by three oxygen atoms.

Napthalene is familiar to us in the form of moth balls. Why is it so light? Because the internal structure of the napthalene crystal is so lace-like, so empty.

This study of crystals is not easy. The atoms are arranged in planes behind one another, and the Braggs must distinguish the reflections from one plane from those of others. This is somewhat like trying to pick out the features of a single man who has been photographed with half a dozen other men to make a composite portrait.

So the Braggs consider crystal after crystal. They plot the location of the atoms. They construct models of the different atomic arrangements that they have studied, and each model is an accurate plan of the crystal whose structure it represents. The crystal proves to be a kind of lattice. Each lattice is known by a special name. There is the simple "cube lattice," the "centered cube lattice," the "face-centered cube lattice," and a few more. The different lattices constitute what may be regarded as styles of crystal architecture. They are identified by the skillful Braggs because nature never displays bad taste in mixing her architectural styles. She may superpose two face-centered lattices to form the characteristic tetrahedron of the diamond, but the tetrahedon structure is always recognizable.

The lattice arrangement of the atoms is not real, like the girders of a building or the wires of a suspension bridge. Only the atoms are real. Probably they are round—bullet-like. What holds them in place? Forces of which we know only too little as yet, but which are the equivalents of very substantial ties and rods. No doubt they are electrical in character. Theoretically, it is possible to hold steel girders together by electromagnetic attraction. In some such manner are the atoms of a crystal held together.

Twenty years ago the atom was "the hypothetical smallest subdivision of matter" as the text-books phrased it. It has ceased to be either hypothetical or the smallest possible particle of matter. It is as real as a rock. It has a definite size, a definite shape, a definite weight and a definite place in a solid body. The Braggs have told us so much about it that it is almost possible to explain why iron is iron and gold is gold. The properties of a substance prove to be due to the peculiar way in which atoms are architecturally grouped. So, the strength and elasticity of metals, their power of conducting electricity and heat can be explained in terms of their structure as it is revealed by the X rays. The Braggs are not concerned with practical or engineering applications of their discoveries, but it is safe to predict that the day is at hand when the hired chemists and physicists of steel works will find the X rays as useful to them in producing a desired alloy as the crucible or the cupola.

How to Increase the Selectivity of Your Receiver

In the next number of POPULAR RADIO*—for December—one of the foremost radio experts in the world, John V. L. Hogan, will tell the amateur and the novice how to reduce interference by sharpening his tuning.*

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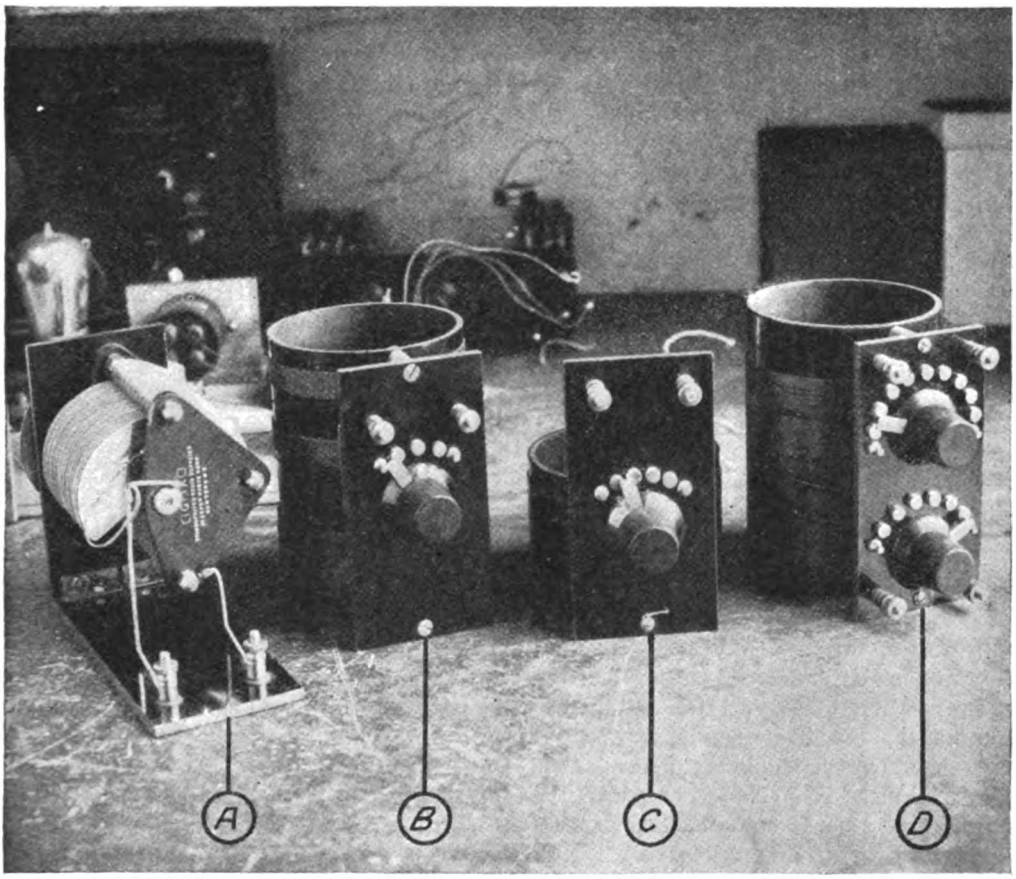

The following panel-mounted units will be found useful additions to any radio experimenter's equipment; A, .001 mfd. variable condenser, B, variable coupling unit, C, short wave tapped tuning coil, and D, a long wave inductance tapped in tens and units.

Handy Units for the Radio Laboratory

By M. B. SLEEPER

IN laying out a radio set the wise experimenter does not proceed with the construction of a finished outfit—unless he is working from drawings—without first laying out a test circuit on the laboratory bench. Under such circumstances it is not always practical to build complete tuning units, and for that very reason the testing instruments shown in the accompanying photograph are extremely convenient.

At the left is a 43-plate condenser mounted on a vertical panel, to which, in turn, is bolted a base panel secured in position by short lengths of angle brass. Binding posts are arranged in the rear for connections to the test circuit. Three experimental inductances also are shown.

The type shown at the left is divided into three sections that are separated considerably in order to reduce the coupling between them. This coil was employed in tests for a wide wavelength range. The center coil was constructed for a short-wave receiver.

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The unit at the right was also made for a long-wave set in which the primary coil was adjusted by means of units and tens switches.

Although the coils were originally built for particular sets, they have come in handy for all kinds of work. Now when an experimental circuit is to be set up it is seldom necessary to wind additional coils. This type of mounting is much easier to handle than plain round coils, the tubes of which must be adjusted by means of loose clips. Moreover, for coupling, they can be moved together or separated.

When fairly tight coupling is required one coil can be set directly on top of the other, either above or below, according to the end of the coil to which coupling is required.

A Home-Made Variometer

—*That Can Be Built at a Cost of 30 Cents*

By DAVID LAY

THE tuning instrument shown in Figure 1 can be made at home with a little care and patience. Inserted directly in a standard aerial, it will cover a range of from 200-600 meters without the use of a condenser.

A disc five inches in diameter is cut out of a piece of "fiber" or cardboard, and the periphery or outer edge is divided into any odd number of parts. Twenty-one divisions are shown in the illustration, but seven, eleven, fifteen, or any other uneven number will serve equally well. Lines should be drawn radially outwards from the center to the marked points, these being afterwards cut out so as to form slots in which the wire is wound.

Before making the slots, however, an inner circle, three inches in diameter, is first drawn, and then cut out to form the "rotor" part of the tuner, the outer annulus or ring forming the stator or stationary part.

Both parts are then cut out with a sharp knife along the radial lines, the slots in the stator being made somewhat wider than those in the rotor. A core one inch in diameter is left at the center of the rotor, as shown.

The outer ring is wound with 24 turns of No. 28 D.C.C. wire, and 60 turns of the same wire are coiled around the inner disc in the well-known basket weave fashion. The inside end of the stator winding is joined to the outside end of the rotor winding, so that the coils run in sequence, a sufficient length of wire being left to allow of relative movement between the two parts. It is also advisable, when cutting out the inner disc, to take off a shaving of about ⅛ inch. This will give a sufficient clearance to allow the inner disc to be rotated.

The two ends for connection to the antenna and ground terminals of the set are taken from the center of the inner disc and from the outside of the ring respectively, and are preferably fitted with "spade" terminals, as shown. The remaining two terminals of the stator and rotor are connected together.

Small brass eyelets are inserted at the top and bottom of the stator to form bearings for the turning spindle, which is fastened in turn to the center disc or rotor by two center eyelets, as shown. The two central eyelets are somewhat smaller than the others, in order to grip the spindle firmly; or a simple lashing of wire may be found more convenient.

The variometer may be mounted in a casing built up from the parts of an old cigar box, as shown. Two pieces of cork are tacked at each side to se-

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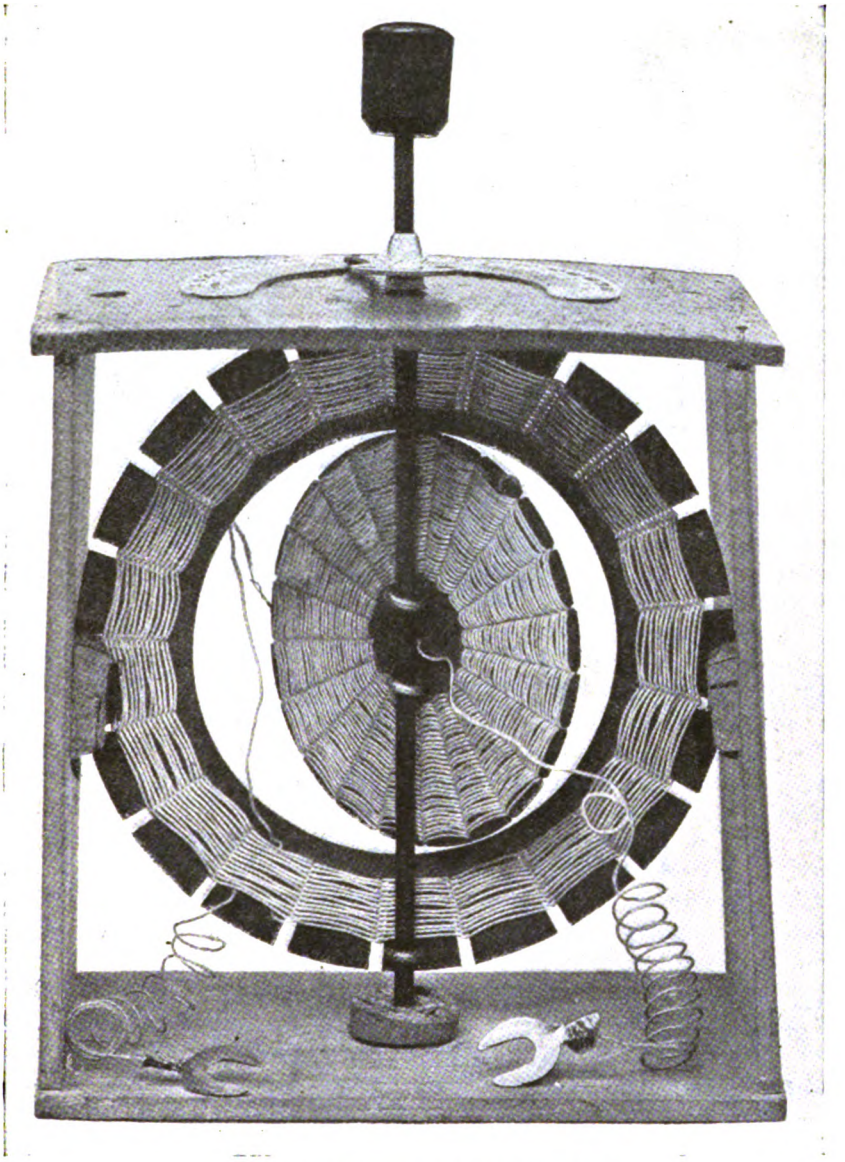

THE SPIDERWEB VARIOMETER

Although this instrument was made by an amateur, out of odds and ends of materials, it proved to be a really efficient variometer. It may be used to tune the antenna circuit or the plate circuit of a regenerative receiver. The frame was made out of the wood from an old cigar box.

cure the outer ringcoil and prevent it from turning, whilst a third piece of cork, tacked to the bottom, serves as a friction bearing for the spindle. Finally a turning knob, pointer, and scale are added.

The instrument gives remarkably good results with an ordinary crystal set, and is sufficiently elastic to pick up amateur telephony, broadcasting, and commercial ships traffic.

It will also serve as a variable inductance for tuning the plate circuit of a regenerative vacuum-tube receiver.

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From a photograph made for POPULAR RADIO

A "TALKING" FIXED CONDENSER

The author listens to music which is reproduced by a poor condenser in which the plates are so loose that they vibrate in unison with the currents that flow through them.

THE TRUTH ABOUT FIXED CONDENSERS

By RAYMOND FRANCIS YATES, R.E.

IT has been said that "upon trifles the greatest gifts of the Gods often hang." So it is with long distance radio—upon trifles the best DX records often hang.

Not the least among these trifles is the little fixed condenser, which is so sadly ignored and neglected by those in whom the temperature of the DX fever runs highest.

Too many fans make the mistake of believing that a fixed condenser should simply consist of a few sheets of tinfoil, separated by greased paper and stored away in a cigarette box filled with wax. But the wise radio man has grown to respect the little fixed condenser and consequently he attaches the greatest importance to it. But what can possibly be wrong with a fixed condenser? No matter how crudely it is made it will "condense." What more is to be expected? We shall see.

A moment's reflection on the history of the condenser will be interesting. It was on October 11, 1745, that old Dean von Kleist, of the Cathedral of Camin, Germany, made an experiment. It was an important experiment, but von Kleist did not realize it. That he was amazed and mystified, however,

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is proven by his letter to Dr. Leberkuhn which follows:

"When a nail or a piece of brass wire is put into a small apothecaries' vial and electrified, remarkable effects follow; but the vial must be *very dry and warm.* I commonly rub it over beforehand with a finger on which I put some powdered chalk. If a little mercury or a few drops of spirits of wine can be put into it the experiment succeeds the better. As soon as this vial and nail are removed fro n the electrifying glass, or the prime conductor to which it hath been exposed is taken away, it throws out a pencil of flame so long that with this burning machine in my hand I have taken about sixty steps in walking about my room; when it is electrified strongly I can take it into another room, and then fire spirits of wine with it. If while it is electrifying I put my finger or a piece of gold which I hold in my hand, to the nail, I receive a shock which stuns my arms and shoulders."

This was the birth of the Leyden jar. In January, 1746, Peter Van Musschembroeck made the same discovery in the University of Leyden, hence the term "Leyden jar."

The Abbé Mollet in France later played with Leyden jars or condensers, and killed small birds with a discharge in order to entertain the ladies of the French court. Another experimenter tried to emulate him but did not succeed until he struck upon the happy thought of grouping the jars together and in this way obtaining a more powerful discharge.

Like the storage battery, a condenser is called upon to hold electricity. This is a crude comparison, however, as the storage battery does not actually hold electricity but keeps it stored in the form of chemical energy which is released as electrical energy. There is only one true container of electricity; only one device that can be "filled" with it. It is the condenser. Each condenser has a certain capacity to hold electricity. We measure liquids in quarts and the capacity of condensers in microfarads. The term "farad" is taken from the first five letters of the name Faraday, in honor of Michael Faraday. Now, a condenser with a capacity of one farad would be as big as a house, and so it is necessary to measure the capacity of condensers in microfarads. (A microfarad is one-millionth of a farad). Even a condenser of one microfarad capacity is too large for general use in radio measurements. Fixed condensers used in radio-frequency circuits usually extend from .0001 microfarad to .0025 microfarad.

We have probably been told many times that a condenser is made up of two conducting surfaces separated by a dielectric. The word dielectric is one of those high-sounding words used by the electrical expert to denote an electrically non-conducting medium. Therefore, we find dielectrics in condensers consist of paper, glass, oil, air or mica. The two last named substances are by all means the best as we shall later discover.

The capacity of a container depends entirely upon its dimensions. This is partly true of condensers—the larger their surfaces and the greater the number of plates, the higher the capacity will be. There is also two other factors which help to determine the capacity of a condenser. These are the thickness of the dielectric and also what is known as the "dielectric constant." The closer the conducting plates of a condenser, the higher the capacity will be. This means that we must place between them a dielectric as thin as possible and yet with a high insulating strength. A poor dielectric, however, no matter how thin it may be, will not give us an efficient, high-capacity condenser. These requirements make mica the ideal dielectric for fixed condensers, and tinfoil the universally used conducting medium. Mica can be split into sheets with a thickness of only a few thousandths of an inch. This makes it possible to build up a condenser of high electrical capacity, of high insulation strength and small dimensions.

When a condenser is charged (filled), static electrical pressure is stored between the metal sheets. In the case of radio-frequency currents this process

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From a photograph made for POPULAR RADIO

THE "SQUEEZE" METHOD OF TUNING

This ingenious fan tunes his set by means of a cheap paper condenser which is connected in series with his single-circuit set. When he wants to listen to one station he holds it loosely, but when he wants to hear another station, he pinches it between his thumb and forefinger. This changes the capacity of the condenser and tunes either station in or out.

takes place with lightning-like rapidity. Like a quart measure, when the condenser becomes filled or charged it runs over and discharges. With a liquid stream of given force, it would require longer to fill a two-quart measure than it would a one-quart measure, and likewise with a given electrical pressure it would take longer to fill a 1-microfarad condenser than it would a ½-microfarad condenser. The same holds true in the case of discharge. One would take twice as long to discharge as the other.

The character of a condenser discharge is oscillatory in nature; that is, it dashes back and forth alternately and dies out. If we place one end of a steel strip in a vice, pull it back and release it it will vibrate, and the amplitude of these vibrations will gradually diminish until the strip is at rest. A condenser discharges in similar fashion. The released currents dash back and forth from one side to the other, charging and discharging and recharging and redischarging the device until it is "empty." The time occupied by the twinkling of an eye is long compared with the time required for the discharging of a small condenser. Small condensers may be charged and discharged millions of times in a single second, larger ones, of course, require more time.

What has all of this to do with the use of fixed condensers in receiving sets? This is the interesting question that we will now consider.

When a condenser is being charged the negative and positive impulses of the charging current exert an actual physical pressure upon the plates of the condenser. This pressure is due to the electrical repulsion and attraction which

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tends to tear the conducting medium away from the surface of the dielectric. This is *not* theoretical. It is a known and observed fact which every radio fan may verify for himself if he wishes. The phenomenon is not noticeable when radio-frequency currents pass through a condenser, as the frequency of these currents is so high that the inertia of the tinfoil plates will not allow them to respond to it. In the case of audio-frequency currents, and condensers in audio-frequency circuits, the result is different. These currents are able to cause the plates of a condenser to vibrate, and for this reason condensers that do not have a permanent capacity and that are not built to withstand this action are a constant source of trouble. They develop circuit noises and produce howling that is often laid to other causes. This is especially true, of course, in connection with vacuum-tube circuits. When the plates of a condenser vibrate they affect the capacity of the whole circuit, as this movement causes the capacity of the condenser to fluctuate within comparatively wide limits although the plates may move only a microscopic distance. These small changes are magnified by the vacuum tubes, and many a hectic noisy set can be brought into the pink of condition by using better condensers.

There are a number of experiments that can be made to demonstrate this point. Under certain conditions the writer had heard speech from a broadcasting station reproduced with an ordinary paper condenser. The reproduction was rather faint, to be sure, but nevertheless it was audible. The plates vibrated in exact sympathy with the audio-frequency currents, and if higher amplification had been used, the reproduction could have been heard at a considerable distance from the condenser.

We have all heard of the "condenser microphone" which is used in many of the modern broadcasting stations. Here we have two plates separated by air. The device is really a simple condenser, and the sound waves impinge upon one of the plates causing it to vibrate. This vibration is sufficient to cause variations in the capacity of the device, and in this way the sound is impressed upon the electrical circuit.

If a carelessly constructed paper condenser is placed in a 500-cycle circuit the thing will emit a humming noise that will exactly correspond to this frequency. The loudness will depend upon the strength of the current.

While the writer was editing the radio columns of a New York newspaper one of his readers wrote in and told how he was using a so-called "fixed condenser" to tune with. When the condenser was left undisturbed he could hear WEAF. When he pressed the condenser tightly between his fingers he was able to change the capacity sufficiently to hear WJZ. Being an ingenious sort of a chap, he connected the condenser to a long wire where it was in reach of his easy-chair. Then he sat there and listened to either of the two stations at will; he pinched the condenser or he let it loose!

From our discourse here it is evident that we should use only such condensers as are of permanent capacity.

Condensers, like batteries, may be connected together in series or in parallel if we wish to arrive at different capacities. If we had three condensers of .001 mfd. capacity and wished to use them as a single condenser of .003 mfd. capacity, we would simply connect them in parallel. We must always remember then that we add the capacities of the condensers when we connect them in parallel. The following simple formula expresses this:

Capacity $.001 + .001 + .001 = .003$ mfd.

If the condensers are connected in series the formula becomes:

$$1/c = \frac{1}{.001} + \frac{1}{.001} + \frac{1}{.001}$$

$$1/c = \frac{3}{.001} \text{ or } 3C = .001 \text{ or } C = .00033 \text{ mfd.}$$

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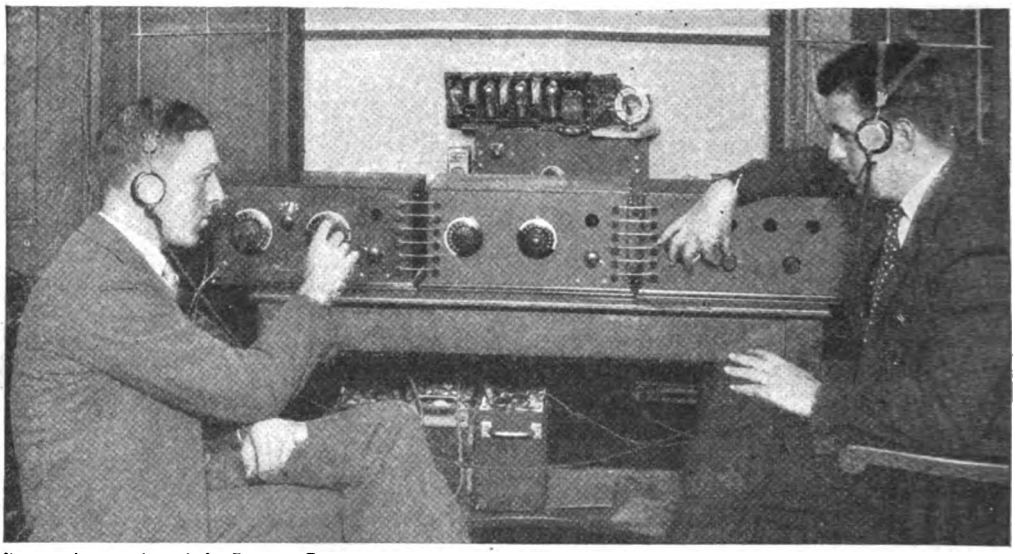

From a photograph made for POPULAR RADIO

THE TWO DESIGNERS DEMONSTRATE THEIR EXPERIMENTAL SET

The new receiver consists of three parts in separate cabinets. The tuner at the left is being operated by Mr. Haynes, the builder of the set; the oscillator is in the center and the amplifier at the right is being adjusted by Mr. Cockaday.

HOW TO BUILD THE NEW REGENERATIVE

Super-heterodyne Receiver

PART I

Here is a new and remarkable type of super-heterodyne which is more sensitive, more selective and more simple to tune than any other kind of multi-tube receiver yet developed. The costs of the parts approximate $100, and anyone who can build and operate an ordinary regenerative set can build and operate this one. While the principle of the super-heterodyne receiver is patented, this set is not on the market, and the following description of it is published for research and experimental purposes only.

By LAURENCE M. COCKADAY, R. E.

THE super-heterodyne receiver is the most *sensitive* receiver yet developed. If it is properly designed it is also the most *selective*. Its one drawback, heretofore, has been its *complexity*—complexity of construction and operation. This and the fact that the amateur and broadcast listener cannot afford such a costly piece of apparatus as it has been up to this time has kept the super-heterodyne from gaining the popularity that it justly should have received.

However, the super-heterodyne (or any other type of set) must have the following qualities before it can ever be acclaimed by the multitude as a really popular circuit.

1. *It must be selective.*
2. *It must be sensitive.*
3. *It must be easy to construct.*
4. *It must be inexpensive.*
5. *It must be easy to operate.*
6. *It must be economical from an "A" battery standpoint.*

Although the super-heterodyne meets

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the first two points better than any other known type, it has always been termed the "Rolls-Royce" of radio. But, beside being the most selective and sensitive it was also complicated, expensive, and could not be built by any but the most experienced engineers. It has always imposed a heavy strain on the "A" battery on account of the large number of tubes necessary to take advantage of its extraordinary amplifying powers. These factors have kept it, up to the present time, as the "lord of all radio receivers," but unfortunately they have also limited its use to a chosen few who have had the price, the ability and the patience to master its complications.

The authors of this article have long realized the possibilities of this wonderful circuit and they have, during the last six months, devoted much time to research for the purpose of developing a simplified super-heterodyne that is worthy of the name.

Of course, with the new low-filament-consumption vacuum tube such as the C-301-A and the UV-201-A, the set can now be made efficient as far as "A" battery loading is concerned.

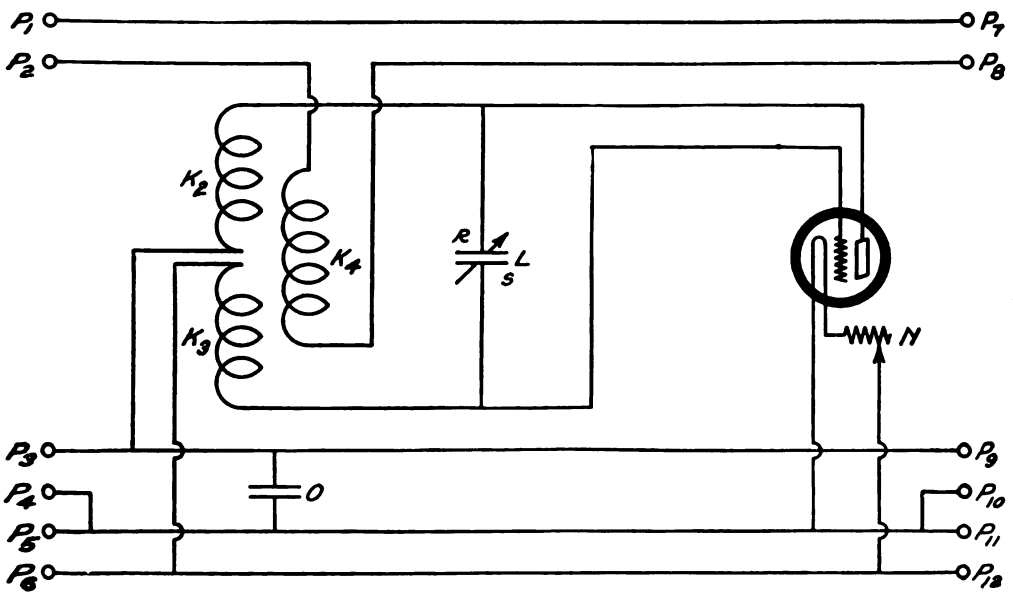
It is now possible to burn four tubes with less filament current than one tube would have taken a year ago.

This fact covers the point raised in the 6th requirement specified at the head of this article.

The circuit as finally evolved (and as will be described in this article) has only two operating controls; for this reason it really *is* simple to operate. (Point No. 5.)

The circuit has been so simplified and the parts used so reduced to essentials, that it is relatively inexpensive. (Point No. 4.)

In its final form the set is really simple to construct. (Point 3.) It can be built in units. This places the super-heterodyne right where it ought to be as the ultimate in radio-reception apparatus but within the reach of anyone who is ordinarily handy with tools and who can afford to experiment with radio at all.



THE EXACT WIRING DIAGRAM FOR THE OSCILLATOR

FIGURE 1: *This diagram shows how to wire up the oscillator panel including the special oscillator coupler, the heterodyne condenser, the tube and the fixed condenser. The binding posts are numbered so that the experimenter will have no trouble in connecting up.*

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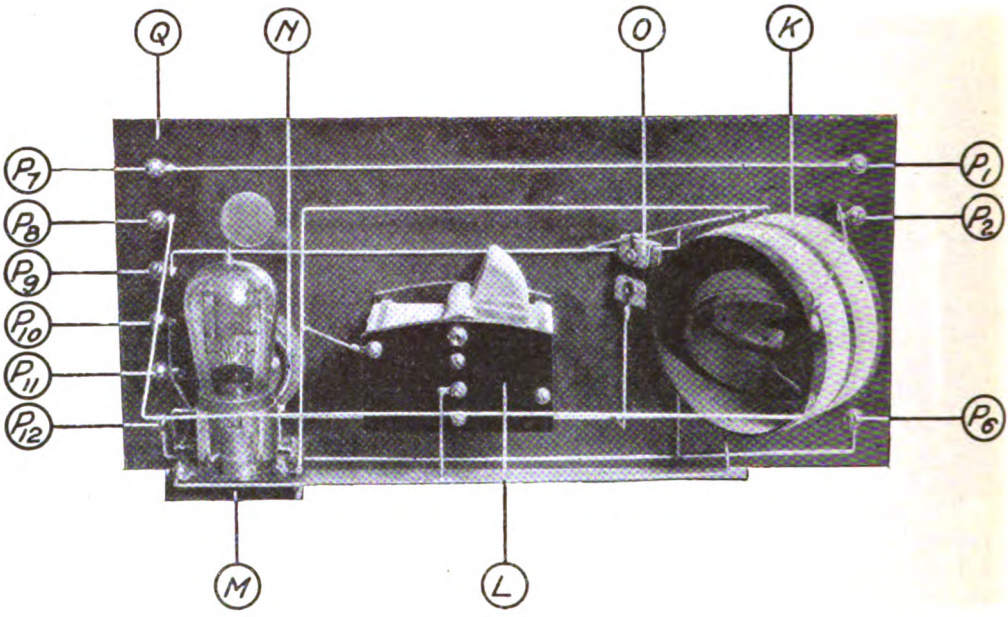
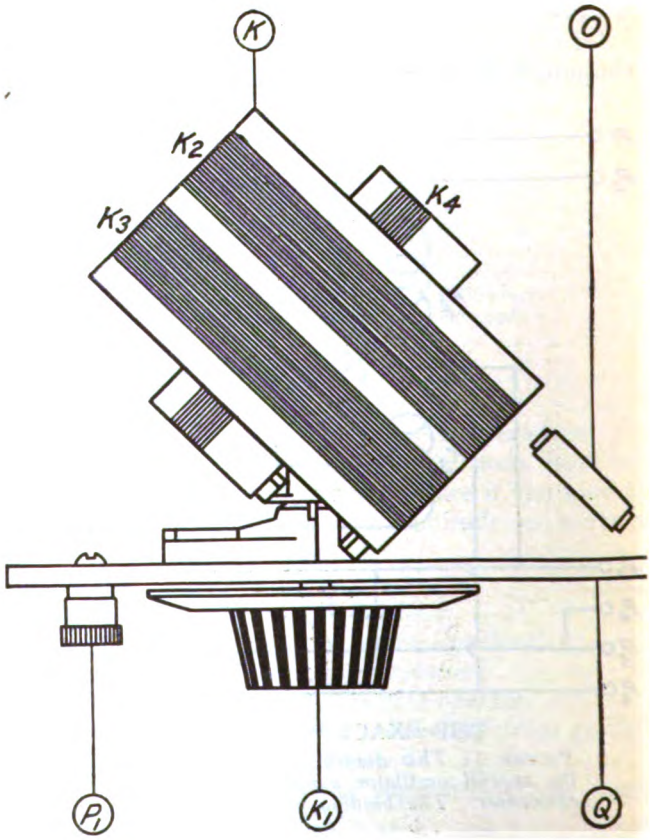


THE INTERIOR OF THE OSCILLATOR

FIGURE 2: *(Above). The parts are designated by letters which reappear in the text and in the other diagrams and drawings. This actual photograph of the instruments indicates the simplicity of the set and should dispel any fears the prospective experimenter may have that its construction is difficult.*



HOW THE PARTS ARE ASSEMBLED

FIGURE 3: *(At right). The diagram extending across the bottom of these two facing pages is a working drawing of the oscillator; it shows the general arrangement of the parts as they are viewed from above.*

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Some of the new features incorporated into the design of the set which make it so suitable for DX reception over wavelengths between 180 and 600 meters are:

The use of the first tube as a *radio-frequency amplifier.*

The use of a heterodyne oscillator *coupled to the plate circuit* of the first tube (instead of to the grid circuit as is usual).

The use of a new type of air-core, radio-frequency transformer which is *sharply tuned to a wavelength of 3,000 meters.**

The use of *regeneration* in the radio-frequency amplifier (which greatly boosts up signal strength without complicating the control).

The *elimination of the variable-tuned circuits* at the input of the radio-frequency amplifier.

The *reduction of the tuning controls to two knobs,* one for the wavelength and one for the heterodyne oscillator.

The successful use of *regeneration* in the first-tube circuit.

The use of the Haynes circuit *for tuning.*

The use of the *new thoriated-filament vacuum tubes throughout* (six tubes).

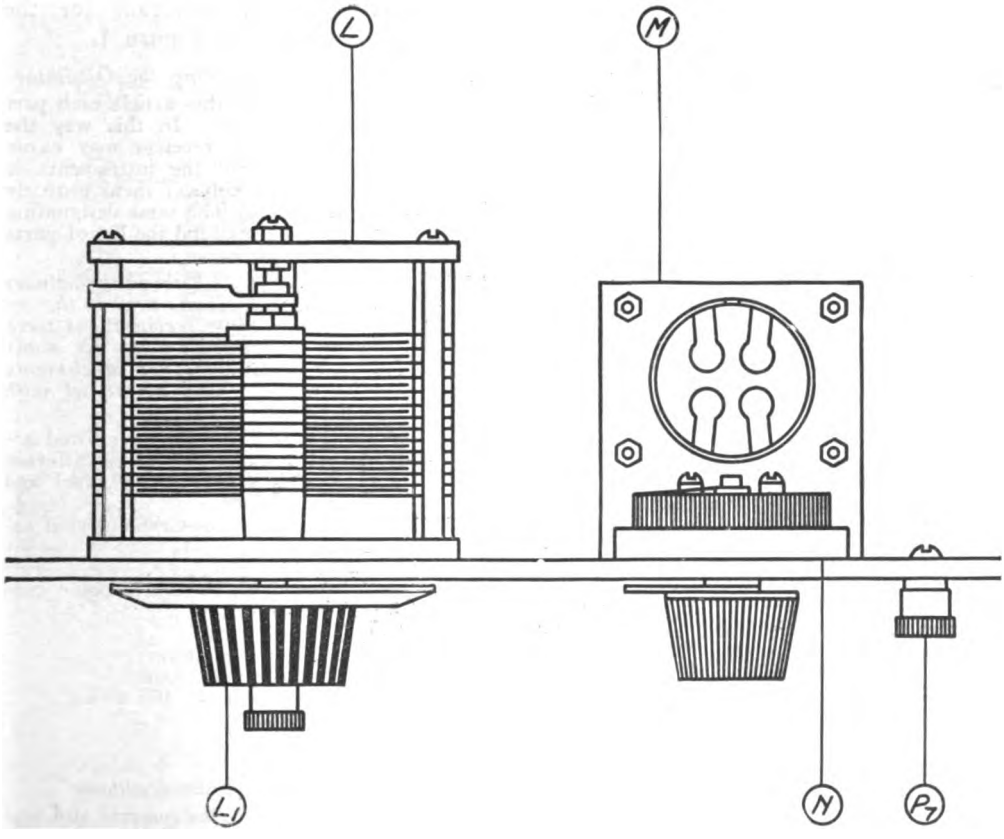
The use of a *new oscillation coupler* for the oscillator.

The set is constructed in three parts; the *tuner,* the *oscillator,* and the *radio-frequency amplifier.*

The tuner was described in the September, 1923, issue of POPULAR RADIO.

The oscillator will be described in this article. The radio-frequency amplifier will be described in the December issue of POPULAR RADIO along with a

*The authors wish to thank Mr. McMurdo Silver for the important work that he has contributed toward the perfection of the radio-frequency transformers.



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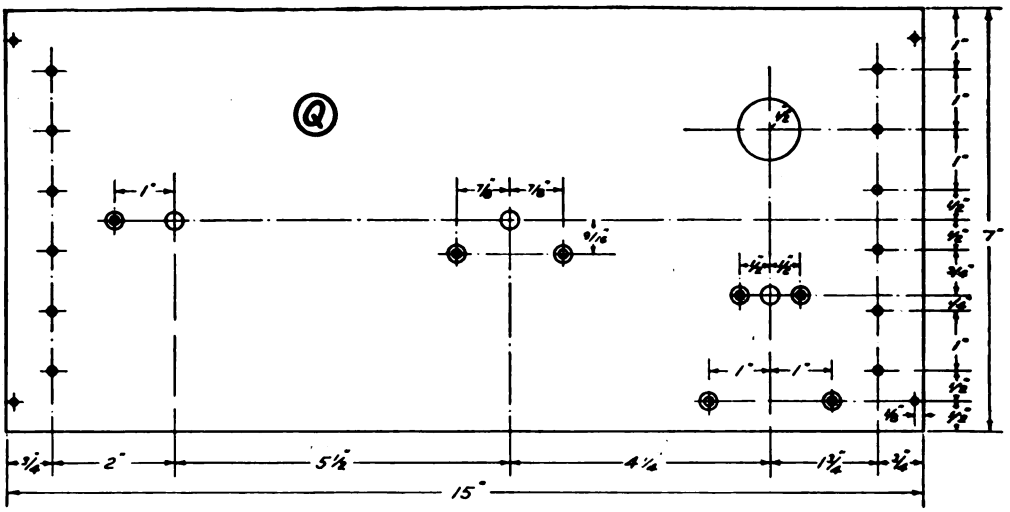

THE DRILLING PLAN FOR THE PANEL

FIGURE 4: *This drawing shows where to drill the holes in the panel for mounting the instruments and attaching the binding posts. The correct spacings are given for the holes. The holes outlined with a double circle should be countersunk.*

full, detailed description of the proper way to set up the complete receiver, and how to adjust and tune it. Although the receiver will bring (in New York City) all the western broadcasting stations and DX amateur transmitters throughout the country, on a loud-speaker, without any audio-frequency amplification, if the builder so desires he may use the two-stage amplifier described in the October issue of POPULAR RADIO. This will produce too much volume on almost any signals for the ordinary home, but there are some folks who like a lot of volume, and this will give it to them.

All of the units described here are mounted in standard-sized cabinets, and the binding posts are arranged so that they may be simply bridged across from one unit to another when the cabinets are arranged side by side. The batteries are connected to the end unit and the other units are fed through the bridging binding posts. This does away with any unsightly, sprawling connections. The general appearance of the complete set (without the audio-frequency amplifier) is shown in the photograph on page 392.

The actual wiring diagram for the oscillator is shown in Figure 1.

The Parts Used in Building the Oscillator

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below.

¶ *The list of parts here given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

(K2, K3, and K4)—Haynes-Griffin special oscillator coupler;
K1—knob and dial, 3 inch;
L—Fett and Kimmel Micro-tune variable condenser, .0005 mfd.;
L1—knob and dial, 3 inch;
M—Fada panel mounting socket;
N—filament rheostat, 20-30 ohms;
O—Micadon fixed condenser, 005 mfd.;
P1 to P12—binding posts;
Q—composition panel;
R—cabinet.

How to Construct the Oscillator

After procuring all the instruments and materials for building the set, the amateur should

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set about preparing the panel Q, (shown in Figures 2, 3, 4 and 5.

First of all the panel should be cut to the correct size, 7 by 15 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 4.

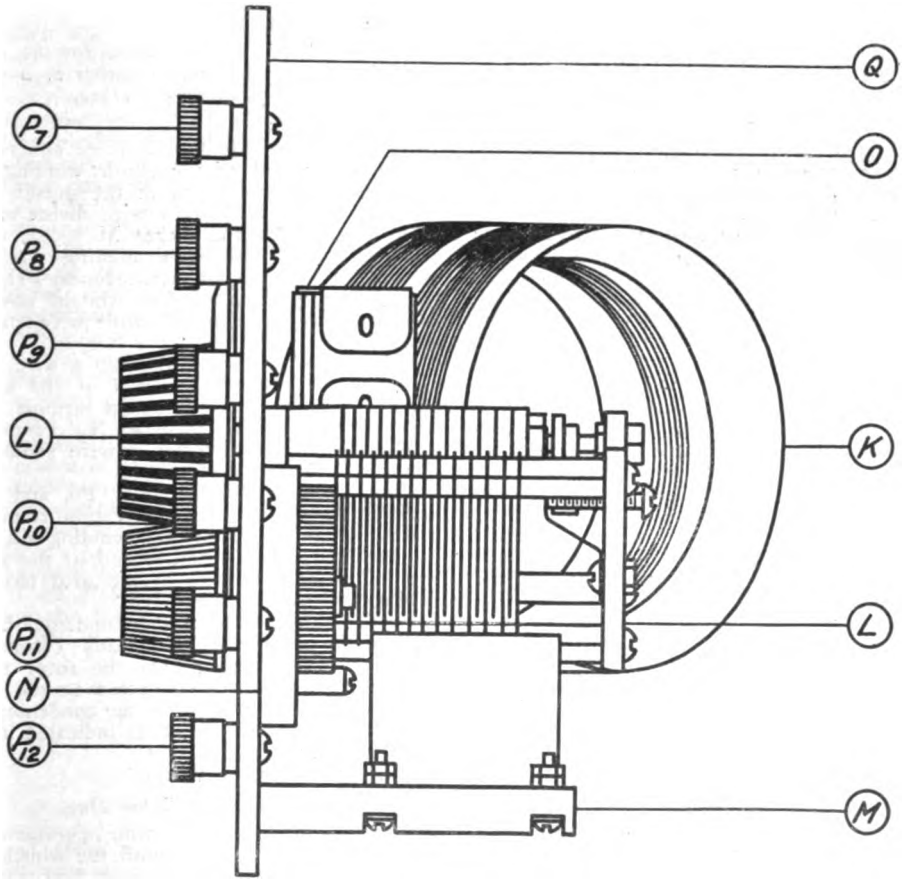
The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish my rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, mount the variable condenser L, by means of two screws inserted through the panel as shown in Figures 2, 3, and 5. The dial L1, should then be fastened to the shaft of the condenser by means of a set-screw.

Now, fasten the oscillator coupler K, in its correct place (Figures 2, 3, and 5) by a single screw and attach the knob and dial K1. The three windings of the coupler are designated as K2, K3, and K4, but these designations are for wiring up and will be considered later.

When this is done, mount the socket M, by two screws fastened through the panel, and mount the rheostat N, just above the socket. The arrangement of these two parts is clearly shown in Figures 2, 3, and 5.



THE SIDE VIEW OF THE OSCILLATOR

FIGURE 5: *This mechanical drawing gives the side elevation of the instruments as they should be fastened to the panel. The binding posts are mounted in a vertical line at each end of the panel.*

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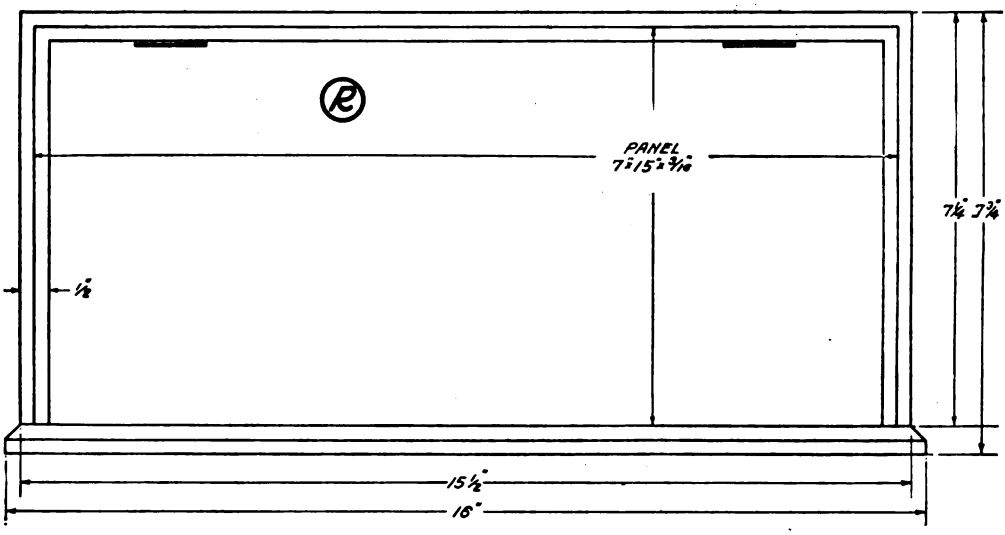

THE DIMENSIONS FOR THE CABINET

FIGURE 6: *This diagram (which contains the front and side measurements for the hardwood cabinet) may be turned over for construction to the cabinet maker or a cabinet of this size may be obtained from almost any radio supply store.*

The fixed condenser O, can be left until the wiring is done as it is to be supported by the connecting wires and does not need to be mounted on the panel.

Now fasten on the binding posts P, as indicated in Figures 2, 3, and 5 by inserting a screw through the panel for each one. The various binding posts are designated in the diagrams by numbers from 1 to 12 but these are only given for ease of identification in wiring. All the binding posts are exactly alike.

The dimensions for the cabinet are given in Figure 6. This cabinet may be made by anyone who is handy with carpenter tools, or, the drawing in Figure 6 may be turned over to a cabinet maker. It should be made of hardwood finished to suit the owner's taste. However, as the cabinet for this set is a standard size, it may be procured from almost any radio store; merely ask for a cabinet for a 7 by 10-inch panel.

How to Wire the Oscillator

The oscillator should be connected up with bus wire in the following manner:

Run a straight piece of tinned copper bus wire from the binding post marked P1, to the post marked P7, as shown in Figure 1. P1, is the top binding post on the left hand side of the panel (looking from the front). P7, is the top binding post on the right side of the panel (also looking from the front of the panel).

Next, connect binding post P2, with one end of the rotor winding K4, (of the oscillation coupler K,) with a wire and connect the other end of the winding K4, with the binding post P8.

Now run a wire from P3, to P9, and also connect another wire to this piece and run it to the inside end of the stator winding K2, (of the coupler K). From the outside end of the winding K2, run a wire direct to the plate terminal of the socket M.

Then run a wire from binding post P4, direct to P5, and from there over to P11, and on to P10. The condenser should now be connected by two bits of wire between P3, and P5.

When this has been done, run a wire from P11, to one filament terminal of the socket M, and from the other filament terminal connect a wire to the rheostat N. From the other side of the rheostat a wire should be connected direct to P12.

Now, connect binding posts P6, and P12, with a wire, and run a connection from P6, up to the inside end of the winding K3, (of the coupler K). The other end of the winding K3, should be run to the grid terminal of the socket M.

Finally connect the variable condenser L, between the plate and grid leads (from the socket M), being sure that the rotor plates of the condenser are connected to the plate lead and the stator plates of the condenser are connected to the grid lead as indicated in the wiring diagram in Figure 1.

This completes the wiring.

What the Oscillator Does

Almost every radio fan who operates a regenerative set is familiar with the whistle accompanying reception of a radio-broadcast signal when the detector is *oscillating*. We know that this is caused by the incoming radio-frequency current combining with the radio-frequency current generated by the vacuum tube when it is allowed to oscillate. However,

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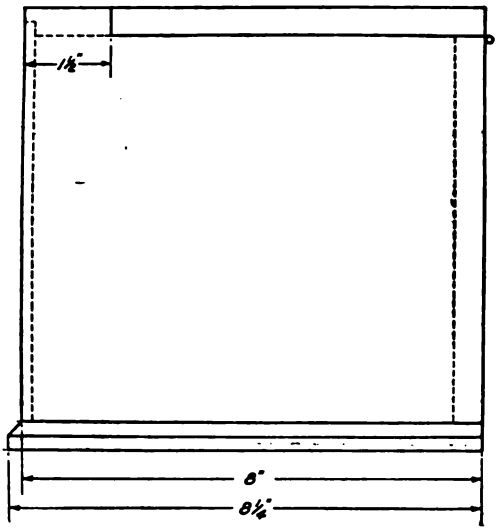

when the wavelength of the oscillating receiving circuit is varied slightly *off* the wavelength of the incoming signal, the whistling note heard in the receivers goes up in pitch. In other words, when the frequency of the local oscillations (generated in the receiver) is identical with the frequency of the signals being received, the whistle is *not* heard. The two sets of oscillations are then in synchronism or in phase with each other.

When the frequency of the local oscillations is varied either up or down, slower or faster than the frequency of the received oscillations, a whistle is heard which starts with a low pitch and gradually increases till it goes way up and up above audibility. The greater the difference in frequency between the local oscillations and the received oscillations, the higher the "beat note" will be. As stated before if we further increase the difference in frequency the note will become inaudible and if it is increased sufficiently a *beat will be produced which will have a radio-frequency wavelength of its own.* The oscillator (or heterodyne as it is more widely known) does this when used for this purpose. It generates an oscillating, radio-frequency current, the frequency of which can be varied at will, so that it will heterodyne or beat with the incoming signals and produce another signal like the incoming signal, only on a higher wavelength!

In this way the incoming signal can be *reproduced* on a higher wavelength, in this case 3,000 meters, at which wavelength, radio-frequency amplification can be carried on with enormously greater efficiency than on the original wavelength!

This is the secret of the super-heterodyne; it permits of super-amplification at a radio-frequency by means of a heterodyne.

In the oscillator, just described, the frequency of the local oscillations is varied by rotating the condenser L, by means of the knob L1.

For those who want to own a receiver that will literally reach out to the corners of the earth and pick out a whisper to recreate it into a mighty shout, here is the set to make. Contrary to belief, it really is a simple set to tune.

For those who decide to build it we recommend starting work on the tuner described on page 222 in the September issue. Then build the oscillator described here, and next month in the December issue we will describe the radio-frequency amplifier unit. This will be the complete set, unless you want to use audio-frequency amplification, which really is not necessary unless a terrific signal from a loudspeaker is desired. You may get the information on the audio amplifier from the October issue.

The second part of this article—which will appear in the December number—will also tell all about connecting up and tuning the complete super-heterodyne receiver, and will be accompanied with full operating data.

The "University of the Ether"

THE *wonderful field that radio is opening up in the province of education is so vast that it is not inconceivable that our whole conception of education may be revolutionized. Some vision of what the future holds will be set forth in* POPULAR RADIO *by one of America's most imaginative authors—Percy Mackaye.*

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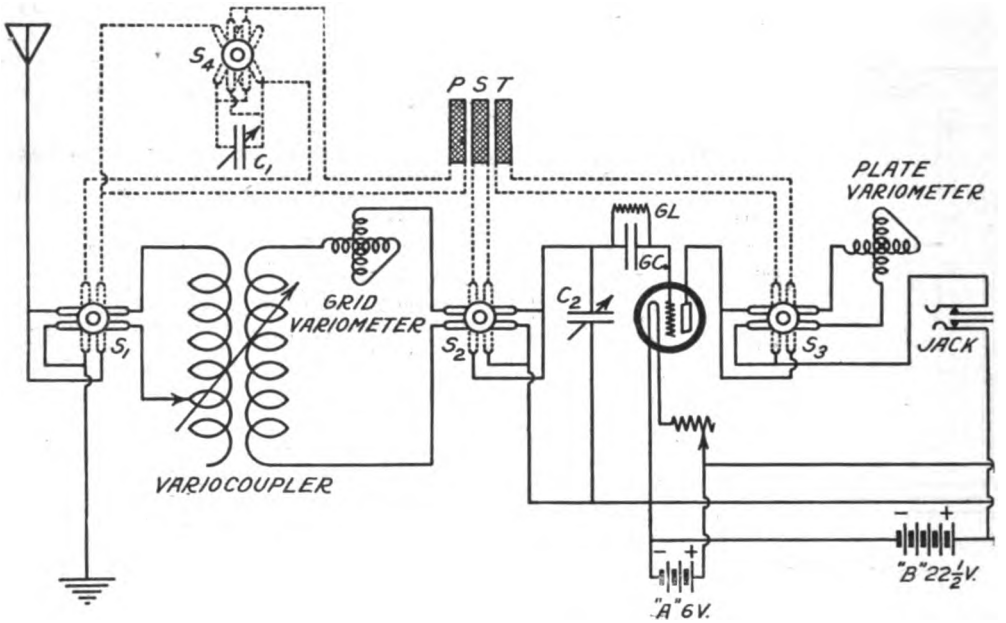

HOW TO BUILD A COMBINATION SHORT AND LONG-WAVE

REGENERATIVE RECEIVER

This set combines the advantages of the three-coil honeycomb tuner for receiving long waves with the advantages of the variocoupler two-variometer regenerative receiver for receiving short waves. The changeover may be made at will by the operator by means of a clever series of simple switches.

By LESTER A. TWIGG

THE modern radio enthusiast wants a receiving outfit with which he can listen in to a large number of distant as well as nearby broadcasting stations. He wants efficiency in his set, which means not only that it must possess sensitiveness, stability and selectivity, but that it must cover a wide range of wavelengths. And he wants all this at the lowest possible cost.

The present-day short-wave receiving sets are designed to give the best results on wavelengths of 200 to 600 meters. While these short-wave sets can be loaded so as to receive messages on longer waves, it is generally conceded that the spiderweb coils, or coils of similar windings, give better results in the reception of long-wave signals. A combination, then, of a short-wave set and a long-wave set is the answer to the demand for efficiency in both short and long-wave reception.

Such a combination, which I shall call an ideal set, can be constructed from standard parts at a cost of about $110, but if the windings are home-made and the cabinet and panel omitted it can be constructed for much less. Properly constructed it will compare favorably with any two-stage set on the market selling for two or three times the cost, and if carefully operated it will give surprising results.

One feature which materially lowers the cost of this set is the elimination of

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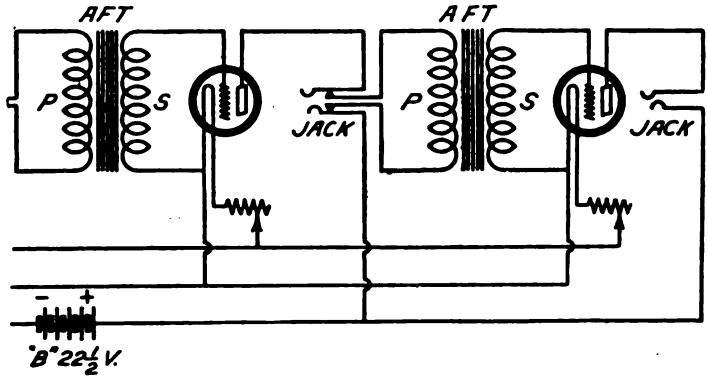
FIGURE 1

This diagram shows the circuit connections for the two tuning units and the detector and two stages of audio-frequency amplification. When either tuner is in use, the other tuner is entirely disconnected and does not interfere with the proper functioning of the one that is being operated.



the double-pole, double-throw switches, substituting series-parallel switches and taps. Four of these switches, shown in Figure 1 as S1, S2, S3 and S4, can be purchased with the necessary taps for less than four dollars; this is less than some shops charge for a one-panel mounted double-pole, double-throw switch. Another feature which lowers the cost is the compactness of the set. All the apparatus, except the batteries, are contained in a cabinet 21 inches long, 12 inches wide and 10 inches deep. This makes all connections comparatively short and adds efficiency to the outfit.

The arrangement of the parts can best be understood by referring to the diagram, Figure 3. A small shelf is fastened to the panel directly under the rheostats, upon which is fastened the two audio-frequency amplifying transformers and the three tube sockets. By extending the shelf to the back of the cabinet, ample room is provided for adding one or two stages of radio-frequency amplification, which today is a very necessary part of the outfit of a wide-awake experimenter.

The duo-lateral, or spiderweb, coils are mounted on the panel and can easily be changed and adjusted to vary the wavelength and tuning as desired. When radiophone messages, or other messages below the 600-meter wavelength are to be received, the switches are turned horizontally to the short-wave set; when signals above the 600-meter wavelength are to be received the proper coils are selected according to the table accompanying Figure 1, and the switches turned longitudinally to the long-wave set.

The variable condenser, C-1, used in the long-wave set, is controlled by switch S-4, as shown in Figure 2-A, and this condenser is shifted to the different positions as shown in B, C and D of Figure 2. This condenser is of the 43-plate type with a capacity of about .001 microfarad. The variable C-2 is a 23-plate condenser with a capacity of .0005 microfarad.

In constructing a set such as has been described the different parts I used were all of standard make. The material used and the costs of the various items are listed as follows:

1 variocoupler with dial	$ 6.00
2 variometers with dials	12.00
3 porcelain tube sockets	1.65
3 filament rheostats	2.25
2 audio-frequency amplifying transformers	7.00
2 double-circuit phone jacks	1.50
1 open-circuit phone jack	.50
7 binding posts	.35
1 grid condenser (.00025 mfd.)	.30
1 grid leak (2 megohms)	.50

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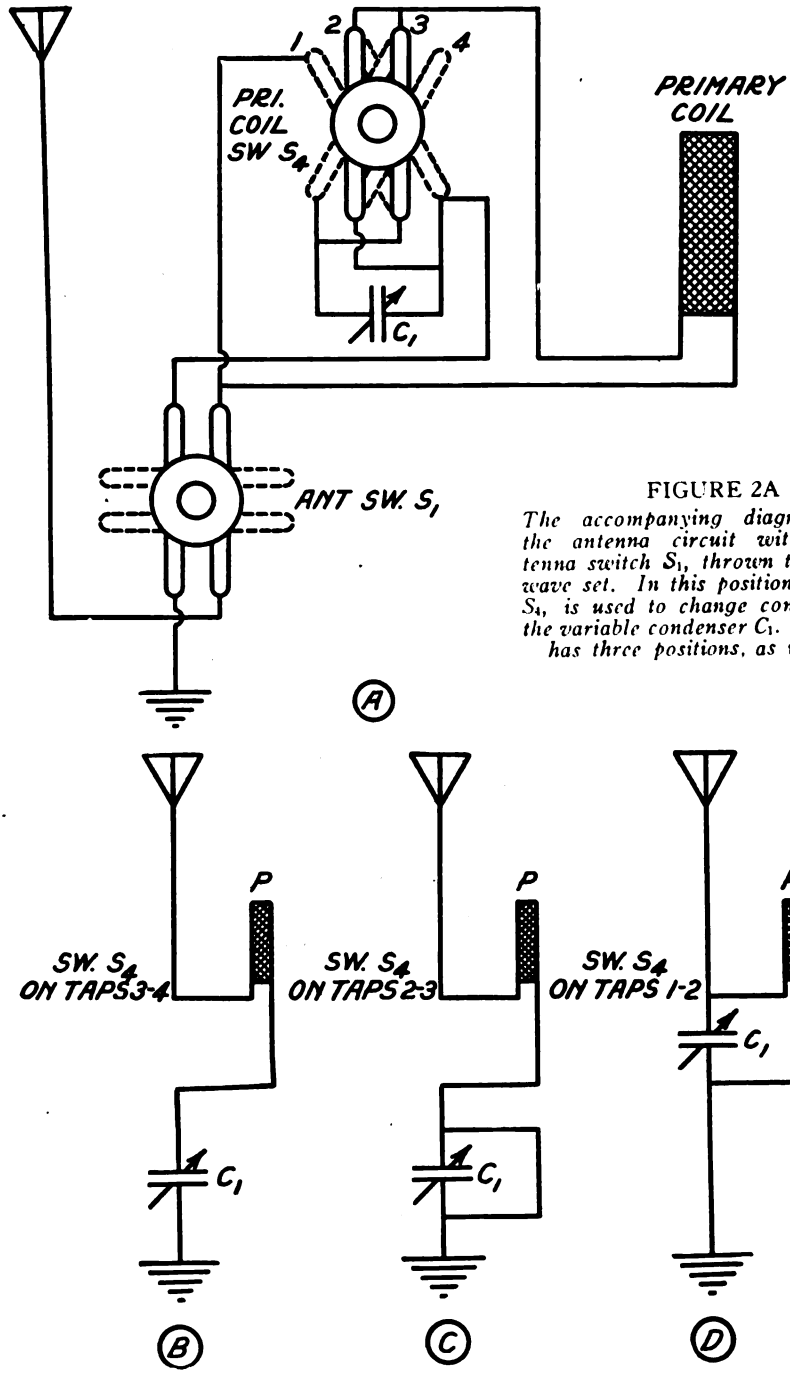

FIGURE 2A

The accompanying diagram shows the antenna circuit with the antenna switch S_1, thrown to the high-wave set. In this position the switch S_4, is used to change connections to the variable condenser C_1. The switch has three positions, as indicated.

FIGURES 2B, 2C AND 2D

In the diagram 2B the switch levers are on 3 and 4 (condenser in series with coil); in the diagram 2C the switch levers are on 2 and 3 (condenser short-circuited) and in the diagram 2D the levers are on 1 and 2 (condenser shunted across the coil). By this means the wavelength of the antenna circuit may be varied over a wide band of wavelengths.

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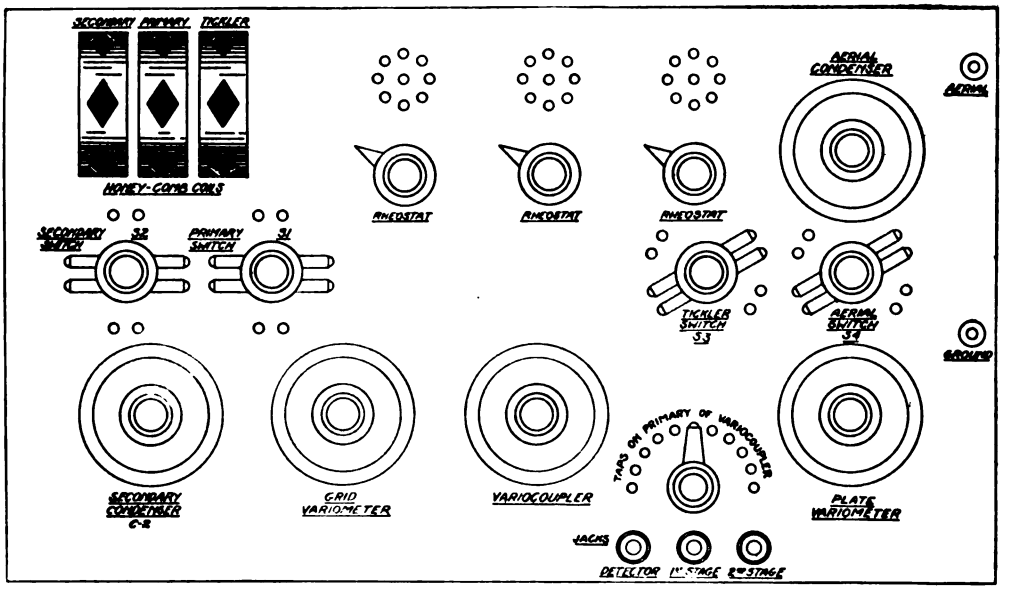

FIGURE 3

A diagram for laying out the instruments on the panel, showing how to put the set into a cabinet.

2 amplifying tubes	12.68
1 detector tube	4.84
2 "B" batteries (22½ volts each)	2.00
1 "A" battery (6 volts, 60 ampere hour capacity)	14.00
1 set head phones (2,000 ohms)	5.00
1 phone plug for jacks	1.00
1 switch lever (1¼ inch radius)	.25
1 100-foot length No. 14 antenna wire	1.00
1 switch (porcelain base S.P.D.T.)	.35
1 piece 50-foot length aluminum wire No. 14, for ground and for wiring outfit	.26
1 cabinet (12 x 21 x 10 inches)	3.25
1 panel (12 x 21 x 3/16 inches)	3.50
1 dozen contact points	.40
ADDITIONAL FOR LONG-WAVE SET	
3 dozen contact points	1.20
4 series-parallel switches	3.16
1 stationary coil mounting	.70
2 pinioned coil mountings	2.20
1 variable condenser (.001 mfd.)	4.00
1 variable condenser (.0005 mfd.)	3.00
1 coil each of the following sizes: L-75, L-100, L-150, L-200, L-250, L-300, L-400, L-500, L-1,000, L-1,250.	15.00
Total cost	$109.84

With this set, located in Washington, D. C., I have regularly heard concerts from Pittsburgh, Indianapolis, Detroit, Cleveland, Newark and Schenectady, besides a number of stations within a radius of 300 miles. Any number of telegraph stations, from almost any distance, may be heard on the long-wave set.

Number of Turns in			*Wavelength*
Primary	*Secondary*	*Tickler*	*in Meters*
35	25	35 =	145 — 350
75	50	35 =	305 — 710
150	100	75 =	635 — 1,660
200	150	100 =	845 — 1,970
300	250	150 =	1,420 — 2,850
500	300	200 =	2,550 — 4,250
500	400	200 =	4,200 — 6,300
1,250	1,000	400 =	6,250 — 14,500
1,500	1,250	500 =	13,600 — 21,000

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BUYING HOME AMUSEMENT WITH YOUR ELECTRIC LIGHT

This is a part of the system recently installed on Staten Island, one of the boroughs of New York City, by which regular programs of music and other interesting material will be supplied to subscribers over the power lines of the local electric service company. The methods of "wired wireless" as developed by General Squier are used. The insulators shown at the top of this photograph carry the high-tension power-distributing wires to which the radio-frequency currents carrying the broadcast material are supplied. A full description of the apparatus used will appear in an early number of POPULAR RADIO.

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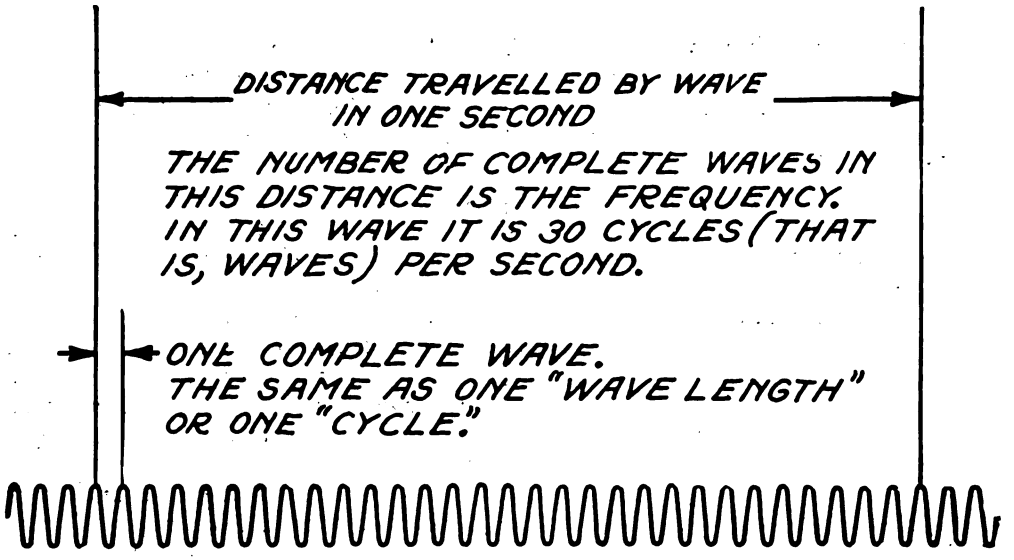
DISTANCE TRAVELLED BY WAVE IN ONE SECOND
THE NUMBER OF COMPLETE WAVES IN THIS DISTANCE IS THE FREQUENCY. IN THIS WAVE IT IS 30 CYCLES (THAT IS, WAVES) PER SECOND.
ONE COMPLETE WAVE. THE SAME AS ONE "WAVE LENGTH" OR ONE "CYCLE."

This diagram shows clearly the relation between wavelength and frequency for the specific wave pictured at the bottom—in this instance the wave produced by the note of a flute.

HOW TO CONVERT

Wavelengths Into Kilocycles

ARTICLE NO. 1 OF A NEW SERIES

Useful facts about ether waves—condensed for your notebook

By E. E. FREE, Ph D.

WHAT is a kilocycle? Why are radio waves now being measured in this new unit instead of the familiar wavelengths? What is frequency?

Of these question let us take first what frequency is and what is its relation to wavelength.

Any wave whatsoever, a radio wave in the ether, a sound wave in the air, a water ripple on the surface of a pond, consists of a succession of pulses moving along one after another. Most waves have a succession of *regular* crests and troughs like ocean waves or like the electric wave, a picture of which is shown in Figure 1.

The part of the wave between one crest and the next following crest is called one complete wave. Its length —that is the distance between successive wave crests—is one wavelength. This is the familiar radio unit.

The *frequency* is merely the number of such complete waves that pass in one second (or what is the same thing) the number of wavelengths in the distance the wave moves in one second.

Consider the arrival of a moving wave at some fixed point; for example, the arrival of a sound wave at your ear.

The wave appears to your ear as a succession of regularly timed pulses,

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one pulse for each wave crest. Each pulse pushes a little against your ear. This sets the drum of the ear to vibrating; inward for each pulse, outward again during each time between pulses. The number of these back-and-forth vibrations of the drum a second is the same as the number of pulses of the wave that arrive a second; it is the same; that is, as the frequency of the wave. The higher this frequency, the shriller the sound seems to your ear.

What you really hear, then, is the frequency, not the wavelength. Frequency, indeed, is always a more characteristic property of waves than length is. Wavelength depends on the *speed* of the wave, and the speed depends not only on the kind of wave but on the medium in which the wave is traveling. Sound waves, for example, move faster in water than they do in air. The wavelength of a sound wave will be greater in water than in air. But its frequency will be the same. It is frequency, not wavelength that is the constant property.

Similarly when you modulate a sound wave onto a radio wave the wavelengths of the two waves do not matter. The sound wave is a slow wave in air. Its single waves are very short. The radio wave on the other hand, is a fast wave in the ether. Its wavelength is relatively very long. The factors that really determine the relation of the two waves, the factors that you need to take account of in modulation calculations, are the respective frequencies of the two waves.

This is one reason why frequencies are coming to be used instead of wavelengths. The use of frequencies makes all kinds of waves comparable directly. Modulation calculations are easier. Interference, harmonics and all other mutual relations of waves are more directly discoverable.

The *kilocycle* is merely a unit of frequency, just as the meter is a unit of wavelength. In electrical terminology a "cycle" means one complete wave, measured, as usual, from one crest to the next following one. (See Figure 1.) The frequency may be expressed, therefore, in cycles. It is the number of cycles a second. An alternating current, for example, may have 60 cycles a second, which means the same as a frequency of 60 cycles.

The kilocycle is merely 1,000 cycles just as a kilometer is 1,000 meters or a kilowatt is 1,000 watts. To say that a wave has 500 kilocycles a second means that it has 500,000 cycles (that is, complete waves) a second.

To convert frequencies and wavelengths into each other requires knowledge of the speed of the wave. Radio waves move with the speed of light. According to the most accurate experimental determinations this speed (in vacuum) is 186,326 miles a second, or 299,860,000 meters a second. For ordinary calculations radio engineers use a round number of 300,000,000 meters a second.

A wave that has 500 kilocycles (which is the same as 500,000 complete waves) a second, will move in that second 300,000,000 meters. The length of each single wave will be, therefore, 300,000,000 divided by 500,000, or 600 meters. This wave will have a wavelength (in vacuum) of 600 meters.

Here are the rules for conversion:

To convert the wavelength (in meters) into the frequency (in kilocycles) divide it into 300,000.

The reverse rule is the same:

To convert the frequency (in kilocycles) into the wavelength (in meters) divide it into 300,000.

The speed of radio waves in air and in non-conducting materials is nearly the same as in vacuum. These rules hold, therefore, for all ordinary calculations.

By way of comparison, the speed of sound waves in ordinary air is about 1,150 feet a second (350 meters a second), not much over one millionth

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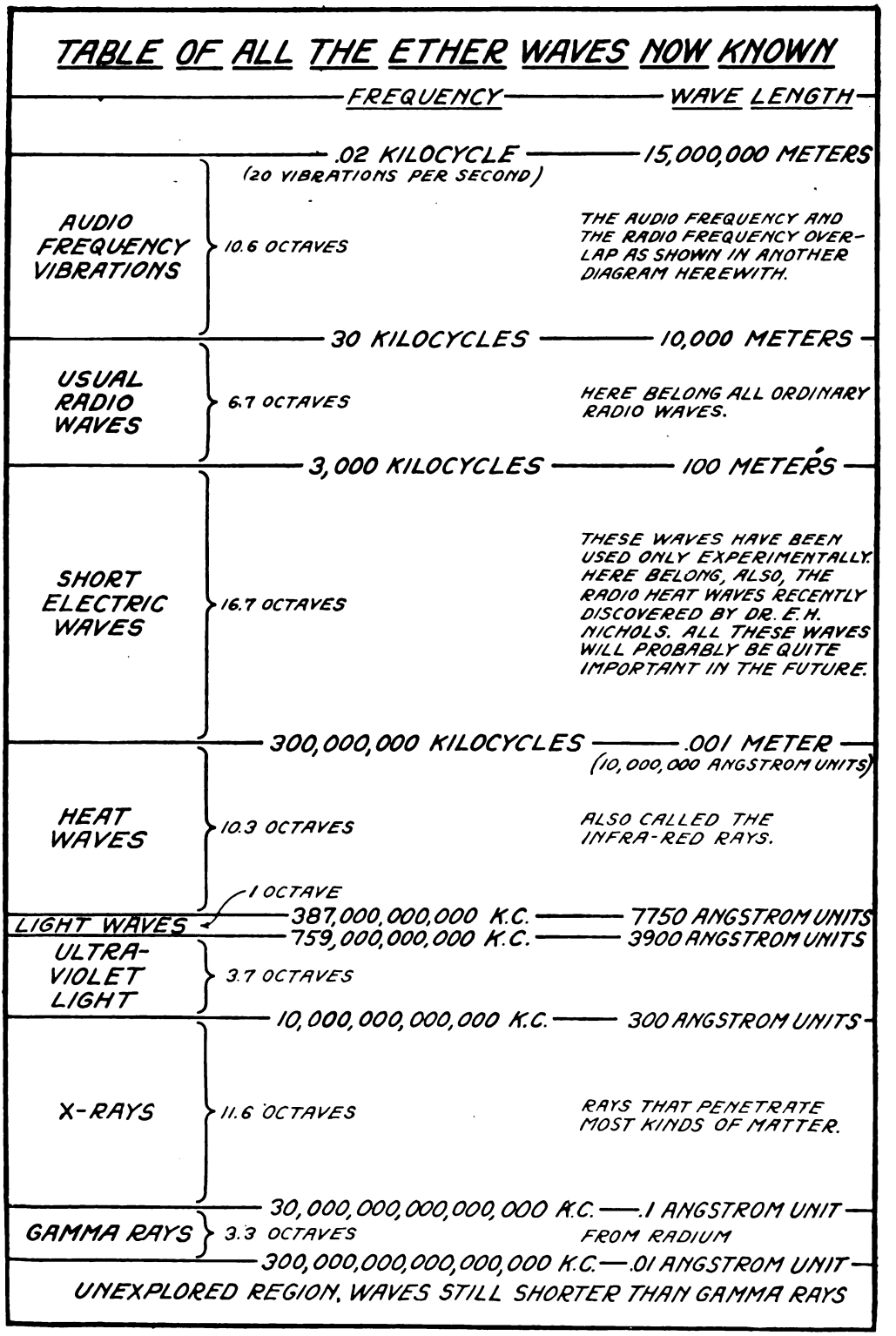

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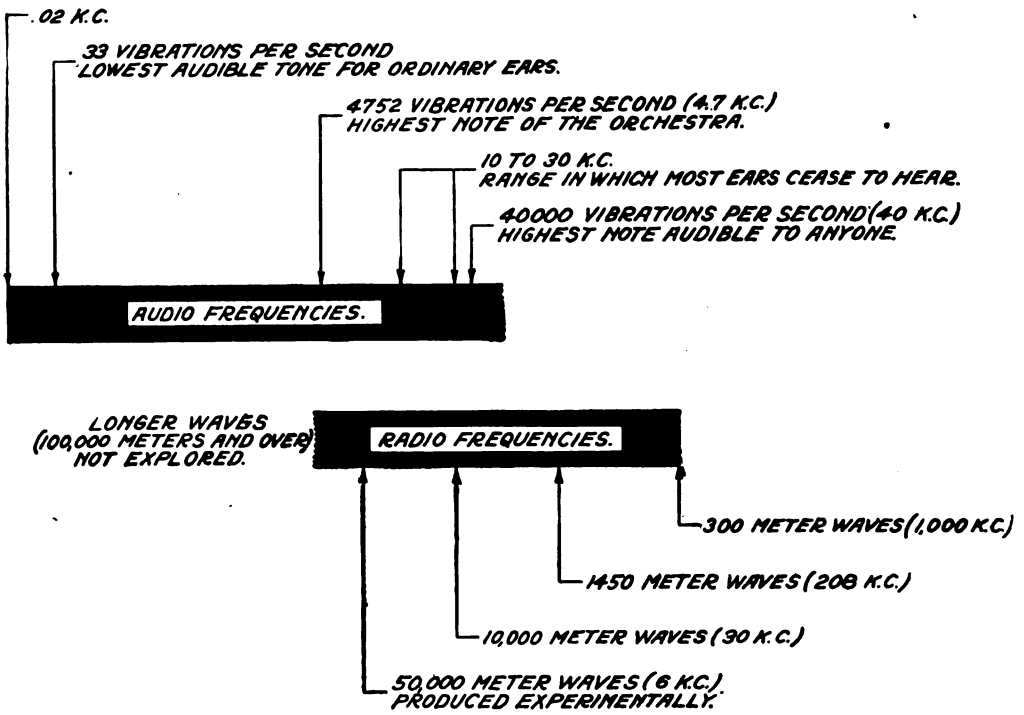
.02 K.C.
33 VIBRATIONS PER SECOND
LOWEST AUDIBLE TONE FOR ORDINARY EARS.
4752 VIBRATIONS PER SECOND (4.7 K.C.)
HIGHEST NOTE OF THE ORCHESTRA.
10 TO 30 K.C.
RANGE IN WHICH MOST EARS CEASE TO HEAR.
40000 VIBRATIONS PER SECOND (40 K.C.)
HIGHEST NOTE AUDIBLE TO ANYONE.
AUDIO FREQUENCIES.
LONGER WAVES
(100,000 METERS AND OVER)
NOT EXPLORED.
RADIO FREQUENCIES.
300 METER WAVES (1,000 K.C.)
1450 METER WAVES (208 K.C.)
10,000 METER WAVES (30 K.C.)
50,000 METER WAVES (6 K.C.)
PRODUCED EXPERIMENTALLY.

RADIO FREQUENCIES THAT WE CAN HEAR

The longer waves of radio overlap into the range of audio frequencies, as is shown in this diagram.

of the speed of radio waves. The speed of sound in water is about 1,500 meters a second. The fastest known speed for sound is in steel; it is about 5,300 meters a second.

Not only radio waves but all kinds of ether waves are designated most conveniently by their frequencies. The table on page 407 gives in form convenient for reference all the ether waves now known with their frequencies and the corresponding wavelengths in vacuum. The term "octave" is borrowed from music. One octave means all the waves between any particular frequency and a frequency twice as great. For example, the first octave of the table includes all the waves between a frequency of 20 cycles a second and a frequency of 40 cycles a second; the second octave is from 40 to 80 octaves a second, and so on.

The entire series of ether waves, from the longest radio waves to the shortest gamma rays, is now known without gaps. There was formerly a gap between the ultra-violet waves and the X rays, but this has been filled by the discovery of some very long X rays lying well within the ultra-violet range. The other former gap, between the heat waves and radio waves, was filled recently by the work of Nichols and Tear (POPULAR RADIO for July, 1923).

The divisions of the waves into radio waves, heat waves and light waves, are made merely for convenience. All the waves belong, really, to one unbroken series. Many of the divisions are overlapped, just as the heat waves overlap the short radio waves and the X rays overlap into the ultra-violet. A similar overlap of the audio frequencies and the radio frequencies is shown in the illustration on this page.

The ether waves that have been most

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studied by scientists are those of light. These differ from the longer and shorter waves only in that they happen to be perceived by the human eye. Physically all the waves are the same. The *color* of light depends upon its frequency, or, what is the same thing, upon its wavelength. The band of color in a rainbow, which scientists call the spectrum, is as follows:

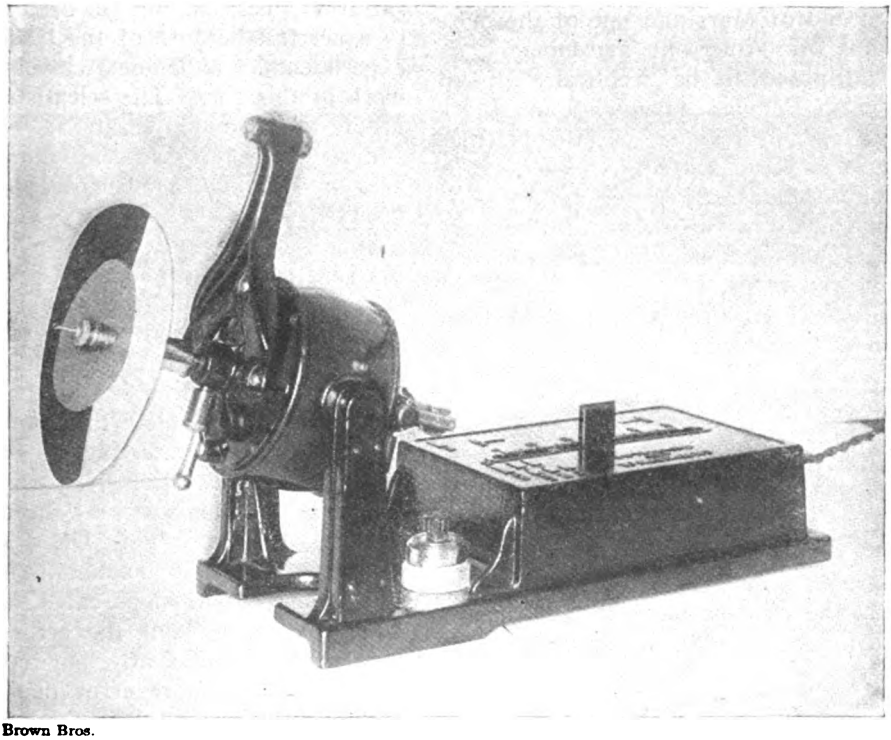
	Angstrom Units
Heat waves (invisible)	longer than 7,750
Red light	7,750 to 6,460
Orange light	6,460 to 5,900
Yellow light	5,900 to 5,600
Green light	5,600 to 4,900
Blue light	4,900 to 4,500
Violet light	4,500 to 3,900
Ultra-violet rays (invisible)	shorter than 3,900

The Angstrom unit used in this table and which is the common unit for the length of light waves, equals one ten-billionth of a meter. It is named after the celebrated Swedish scientist Dr. K. A. Angstrom, who was the first to study and chart the spectrum of sunlight.

Other units of length sometimes used in designating the wavelengths of ether waves, are the following:

1 meter.....equals 1,000 millimeters
1 millimeter....equals 1,000 microns
1 micron.....equals 1,000 double microns
1 double micron equals 10 Angstrom Units

The abbreviation for micron is the Greek letter mu (μ), that for the double micron is ($\mu\mu$); that for the Angstrom Unit is A. U. or sometimes merely A. A double micron is sometimes called a "micro-micron" or a "mille-micron."



Brown Bros.

HOW COLORED LIGHT WAVES ARE MIXED AND JUDGED

One half of the colored rim on the edge of the disk is red, the other half is white. When the disk is rapidly revolved by the attached electric motor the light waves from the two portions of the disk blend in the eye, producing a shade of pink. In the same way the color-blends necessary to produce any desired shade of any color can be worked out in the laboratory. Psychologists also use this same instrument to study the way in which the human eye sees various mixtures of light of different colors.

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Einstein May Be Wrong After All

HAS the Einstein Theory been proved right, finally and certainly, by the photographs taken last year in Australia during the eclipse of the sun and recently announced by Dr. Campbell?*

Many scientists would be inclined to answer yes. But Professor William H. Pickering, distinguished student of the moon and of Mars and one of the most famous of American astronomers, is still disposed to be sceptical. In an article in *Popular Astronomy* for June-July, 1923, he reviews the attempts that have been made recently to check Einstein's famous three proofs of his theory, with results not entirely favorable to the completeness and accuracy of the theory itself.

These three proofs, you remember, were the following:

First, the light from a distant star ought to be bent a trifle as it passes close to the edge of the sun. The exact amount of this bending was calculated from the theory, and it was this amount which was confirmed by the Australian photographs.

Second, some of the dark lines across the rainbow band or spectrum of sunlight ought to be displaced a little in position when compared with the corresponding lines in the spectrum of light produced here on earth.

Third, the Einstein Theory explained, according to its advocates, the slight error long known to exist in the annual motion of the orbit of the planet Mercury.

The predicted bending of the light ray from a star appears to have been confirmed with reasonable exactness. This Dr. Pickering admits. The second proof, the displacement of the solar spectrum lines, has not yet been brought to exact test because of the tremendous experimental difficulties involved in work of this sort. The scientists of the Mount Wilson Observatory, who are admittedly the world experts in this field and who have unsurpassed instrumental equipment for it, are not yet willing to announce any result either for Einstein or against him.

The third proof—with reference to the error in the orbit of Mercury—has usually been considered fully favorable to the theory. Indeed it was the ability of the theory to explain this well-known discrepancy that first recommended it to the serious attention of astronomers. But recent recalculations of the motions of this planet are not, Dr. Pickering points out, quite so much on Einstein's side as has been supposed. The Einstein Theory explains the error in the orbit not only sufficiently, but too much. It accounts for more error than exists.

When all known corrections are applied to the figures, including a correction for the polar flattening of the sun, which seems to have been forgotten in

*See POPULAR RADIO for October, pages 284-285.

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the first calculations, the error in Mercury's orbit works out, Dr. Pickering writes, as 38.1 seconds of arc. Einstein's equations account for an error of 42.9 seconds: over ten percent more, that is, than exists.

This does not disprove the Einstein Theory, but it does mean, Dr. Pickering implies, that we should go a little slow in accepting it as complete and final. Perhaps some modification of it may prove to be necessary.

Even the proof from the bending of starlight, while it seems undoubtedly to be a *fact,* may not constitute such a real proof of the theory as it has been thought. Dr. Einstein, to be fair to him, never called any of these three things a *proof.* He said merely that they were *consequences* of his theory; that they would be true if it was, and assuming, of course, the usual other theories as to the nature of light and the like. In recent years it has begun to seem as if this last assumption might be a rather unsecure one. We begin to suspect that our usual theories of light are not quite perfect. Some facts about X-rays, for example, do not fit into them very well. We may have to modify these theories, and this may change somewhat our interpretation of the supposed Einstein proof.

All this makes it increasingly desirable to secure accurate information about the second proof, the predicted shift of the spectrum lines. Many scientists are working on this, and early results are probable. It is possible, also, that the eclipse of the sun that is occurring in Southern California while this number of POPULAR RADIO is being written, may yield information of importance. No total eclipse of recent years has been so readily accessible to centers of population and none in the

Brown Brothers

DOES THE EINSTEIN THEORY EXPLAIN ERRORS THAT DO NOT EXIST?

Possibly, thinks Prof. William H. Pickering, the distinguished American astronomer, who questions whether the "proof" with reference to the error in the orbit of Mercury does not prove too much.

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International

THE "ELECTRICAL DOG" AND ITS INVENTOR, JOHN HAYS HAMMOND, JR.

This little car, propelled by battery-driven electric motors, contains an arrangement of selenium cells which directs its movement. It follows a light, turning when the light turns, as a dog follows his master.

history of the world has been attacked by such an assemblege of scientists as have gathered in California and Mexico for this one.

Machines That Operate by Light Waves

THE extraordinary property of the metal selenium by which it changes in electrical conductivity whenever light falls on it has been for years an incentive to inventors. Devices employing it have ranged from machines to open window shades when the sun rises in the morning to automatic dogs that will follow you about if you hold up a lamp in front of them. The newest one, of which we read in a recent number of the *Wireless Review* (London), is a device that dims automatically the headlights of your automobile whenever another car approaches yours on the same road.

A selenium cell fixed to the front of your car receives the light rays from the approaching headlights. This changes the resistance of the selenium and actuates a relay which inserts a dimming resistance into your headlight circuit.

So passes a test of road courtesy. When you see the other fellow's lights grow pleasantly dim as you approach, you will not know any more whether it is because he is a member of the fellowship of friendly drivers or whether it is merely because he has money enough to buy a selenium cell.

French Time Signals Are Late

THE report of the British official astronomical observatory at Greenwich indicates that during 1922 the daily time signals sent out by the French radio station at Paris were, on the

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average, .04 second later than the British signals. The signals from the Bordeaux station showed an even greater lag, the average discrepancy being .08 second. Both of these figures indicate the final unexplained discrepancy after all known corrections have been applied.

During the year the American signals averaged .03 second behind the British ones, but this is explained by the British authorities as being due to the time required for the wave to cover the long distance separating the two stations. The German signals from Nauen coincided exactly with the British ones.

More interesting, really, than speculation about the possible cause of the lag in the French signals is the fact that this lag was discovered at all. Such precision in the comparing of times between two distant stations would have been absolutely unobtainable before the development of radio. This is only one of the many ways, as pointed out by General Ferrié in his article in POPULAR RADIO for October, in which radio is proving of assistance to other sciences.

The Future of the Airplane Controlled by Radio

WILL one of the gifts of radio to the world be a mail route encircling the globe in a score or two of hours; moving, that is, as fast as the sun itself? Will we ship freight to Europe overnight? Will the thousand or so men who are necessary to man and operate an ocean liner be replaced by three or four radio operators bending over their keys somewhere in a seaport city?

None of these things is impossible if we are to share the enthusiasm of the

A MAIL CARRIER OF THE FUTURE

A radio-controlled airship recently exhibited in London and said to be capable of making long flights without either passengers or pilot.

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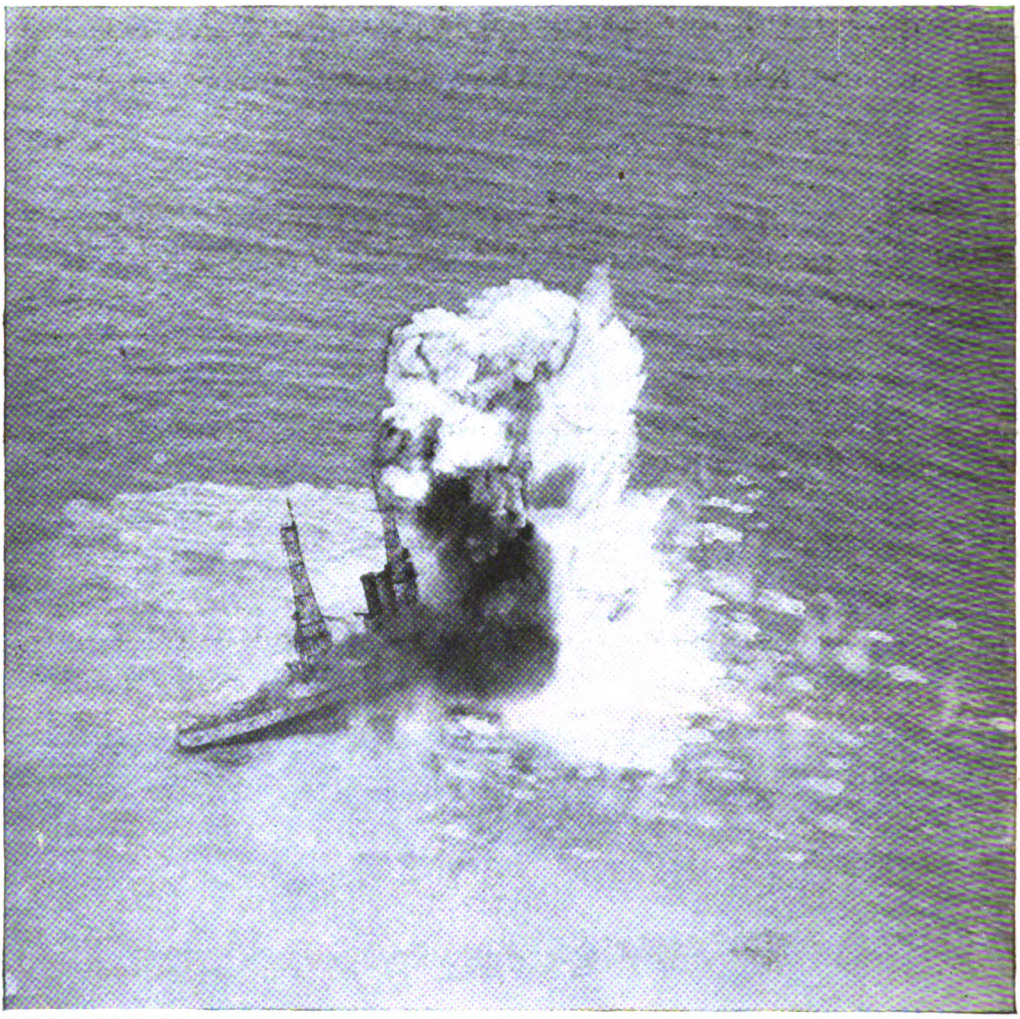

U. S. Army Air Service

RADIO-CONTROLLED SHIPS MAY BE DESTROYED BY RADIO-CONTROLLED AIRCRAFT.

In trials by the United States Navy, the battleship Iowa, *with no one on board, was steered and controlled by radio while aircraft attacked the moving ship with full-sized bombs, simulating the conditions of actual warfare.*

scientists and engineers who gathered recently at the jubilee meeting of the French Society of Civil Engineers to hear and discuss the paper of M. Percheron on the possibilities of the pilotless, radio-directed airplane. In the presence of General Ferrié, the head of the French radio service, of M. Soreau, the expert on commercial aviation, and of many other distinguished members of the Society, M. Percheron described some of the French experiments, military and otherwise, in which automatic devices controlled the flight of planes; some of them carrying pilots who acted merely as observers and never found it necessary to touch the controls, others entirely without human passengers and dependent for their control altogether upon the radio signals sent out from ground stations.

The fact that such devices were developed in the latter days of the war by most of the allied nations is common

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knowledge, but they have been thought of in the main as having military value rather than as being useful in time of peace. But it is evident, M. Percheron said, that a perfected man-less plane will make available for ordinary use the higher regions of the atmosphere where the air is thinner and the speed attainable by a plane is correspondingly greater. Mail planes cannot now fly at these great elevations because of the discomfort to the pilot. If there is no pilot this limit disappears.

That our own aviation authorities are not unmindful of these possibilities is evidenced by a recent statement made by General Mitchell, of the Air Service, U. S. A., in the course of an interview predicting that airplanes could probably rise without great difficulty to 55,000 feet above the earth, nearly four miles above the present record. At such a height, the general said, planes might be flown to Europe in a few hours. Automatic machinery in the plane would send out radio signals at regular intervals. These signals, picked up by properly placed direction-finders on shore would enable the operators here to keep in constant touch with the position of the plane and to send out from time to time the necessary control signals to direct its flight.

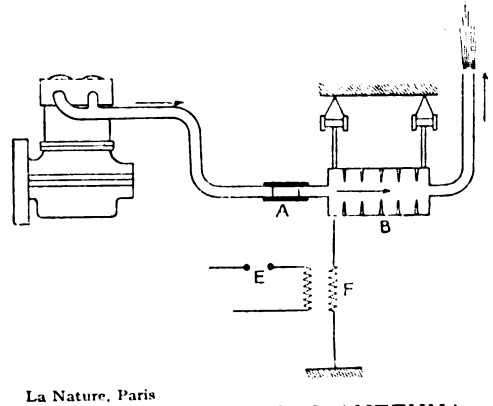
All this is wonderful enough, but a suggestion may be added. If radio movies prove possible, as it now seems almost certain that they will, such a machine placed in the plane would enable the operator at home actually to see out from the plane at all times and to control its flight visually, just as a living pilot would do. Think of the possibilities for military observation during war, of exploration over unknown country, of stay-at-home travel! One could actually send an eye out anywhere in the world to look at things and to report instant by instant whatever was visible from where it happened to be. The traditional magic carpet, gives place to the radio eye.

Exhaust Gases Used as an Antenna

ACCORDING to a note in *La Nature* (Paris) Mr. A. M. Low has patented a novel and surprising method of doing away with metallic antennas, either for reception or transmission. He uses the exhaust gases of his automobile or of any other internal combustion engine. These gases, of course, are discharged from the engine in a highly ionized condition so that they form a conducting cloud extending some distance into the air, just as a cloud of smoke or steam rises some feet above a smoke-stack. If an alternating potential is communicated to such a cloud a wave will be propagated from it much as from a metallic antenna.

The arrangement of the apparatus is shown in the accompanying illustration. The muffler is insulated from the body of the engine and is connected to the exhaust line by means of an insulating coupling. The radio signal wave is fed into the muffler, the internal points serving for the more perfect communication of the impulses to the ionized gas.

The invention is expected to have its main use in airplane radio where it may result, experts believe, in doing away with the trailing wire and other forms of metallic antenna.



La Nature, Paris

THE EXHAUST-GAS ANTENNA

B, is the muffler, insulated from the engine by a non-conducting suspension and by the insulating coupling A. Radio impulses enter the muffler by way of F, and are communicated to the exhaust, D.

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THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask the* SERVICE BUREAU.

THE flood of inquiries that has poured in upon the Service Bureau has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

In justice to our regular subscribers, the Service Bureau is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry. No inquiries can be answered personally or by telephone.

QUESTION: Can spider-web coils be substituted for honeycomb coils in a triple-coil honeycomb circuit?

BREWSTER JENKINS

ANSWER: Yes. These two types are often employed interchangeably in the same circuit using a primary coil, a secondary coil, and a tickler coil.

* * *

QUESTION: What is the average plate current of an ordinary six-volt detector tube? I get a reading of only about ¾ to 1½ milliamperes, and I was given to understand that the tube should have a much greater plate current.

A. MILLER-ROBERTS

ANSWER: In order to work on the proper part of the curve (of grid voltage plotted against plate current) to obtain detection, the tube's plate current will be small. The values you have given are representative of the values ordinarily found. However, if the tube were used as an amplifier the plate current may be raised to several times that value.

QUESTION: Why is it that when I change wavelength on my one-tube, crystal-detector reflex receiver, I also have to change the adjustment of the crystal detector? If I do not, the set oscillates. Why is this?

ORVILLE F. ROGERS

ANSWER: If you tune the set to any given wavelength and then lift the crystal adjustment spring off the crystal you will immediately hear the set commence to oscillate. When you adjust the crystal for that wavelength you also are adjusting the resistance of the secondary circuit of the radio-frequency transformer to a certain critical value that stops the set from oscillating. It is really a transfer of effective resistance from the crystal circuit through to the grid circuit of the first tube that controls regeneration in this type of receiver.

When you change wavelength, however, you need a *different* resistance in the crystal circuit to keep the radio-frequency circuit stable, and so you have to readjust the crystal until you have obtained this value to get the best results.

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QUESTION: What is the best test for deciding what kind of horn to buy for a loudspeaker? Sometimes the dealers do not have a set going and one has to take their word for it that the type they offer is as good as they say. Can you tell me of any precautions or hints that might help me to pick out a good one?

REYNOLD FENNER

ANSWER: The best test of a loudspeaker is to listen to it in operation. However, you may be helped by the following suggestions:

1. Try tapping the horn with the finger; if it rings with a high tinny note it will reproduce with a twangy sound and will probably rattle on some of the higher tones. It should give off a dull, low thud, if it is to operate satisfactorily.
2. Composition fibre horns are usually less resonant than thin metallic horns.
3. The better type of energizing unit has a moving element that is not in tortion when no signals are being received. That is, they are usually not affected by the magnetic pull of the magnets when signals are not passing through the coils.
4. The base of the instrument should be solid and heavy.
5. The horn should have as few sharp curves or corners as possible.
6. If you take the horn off and sing the musical scale into it with as near equal intensity as you can, each note should be of approximately the same strength and no particular note should stand out above the rest.

QUESTION: Is there any difference between the operating principle of the Fleming valve and the new diode tube?

J. C. D.

ANSWER: They both work on the same principle as an electron-discharge valve. The last mentioned tube is a recent development of the Fleming valve. They may both be used as a detector but neither of them will operate as an amplifier.

* * *

QUESTION: Please let me have a diagram of the triple-coil honeycomb outfit for one tube. I was told that this is a good regenerative circuit for a beginner to start with. I want to build it myself.

ALAN BRENT

ANSWER: You will find the hook-up in Figure 1. The instruments necessary to include in the circuit are the following:

L1—honeycomb or duolateral coil, L-35 or L-50;
L2—honeycomb or duolateral coil, L-50;
L3—honeycomb or duolateral coil, L-75;
VC1—variable condenser, .001 mfd.;
VC2—variable condenser (vernier), .0005 mfd.;
GL—grid leak, 1 or 2 megohms;
GC—grid condenser, .0005 mfd.;
C—mica fixed condenser, .0005 mfd.;
R—filament rheostat.

If a dry-cell tube is used, the filament rheostat should be suitable for the tube; ask the dealer. If a regular 6-volt detector tube is used, use a 6-ohm rheostat.

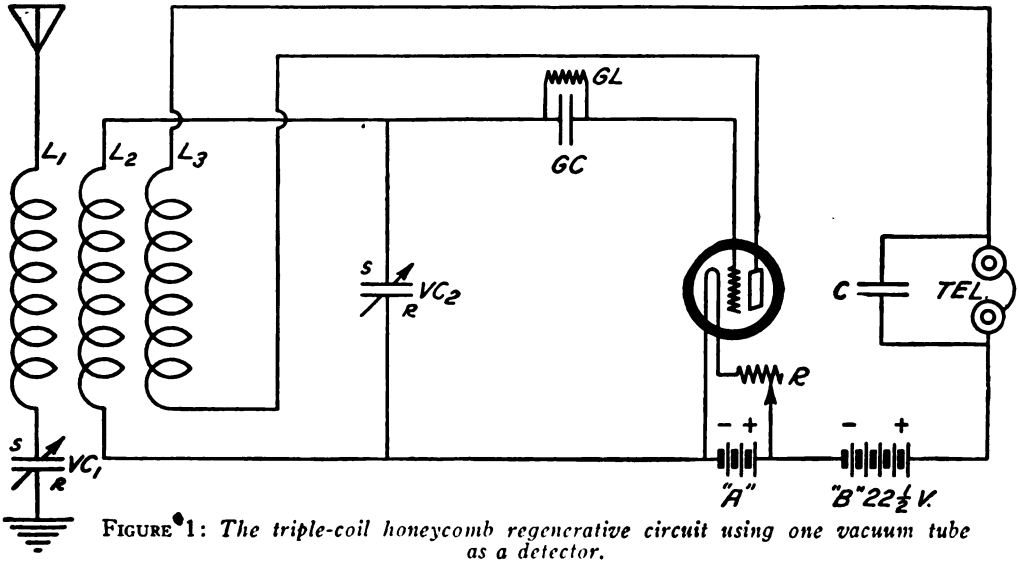

FIGURE 1: *The triple-coil honeycomb regenerative circuit using one vacuum tube as a detector.*

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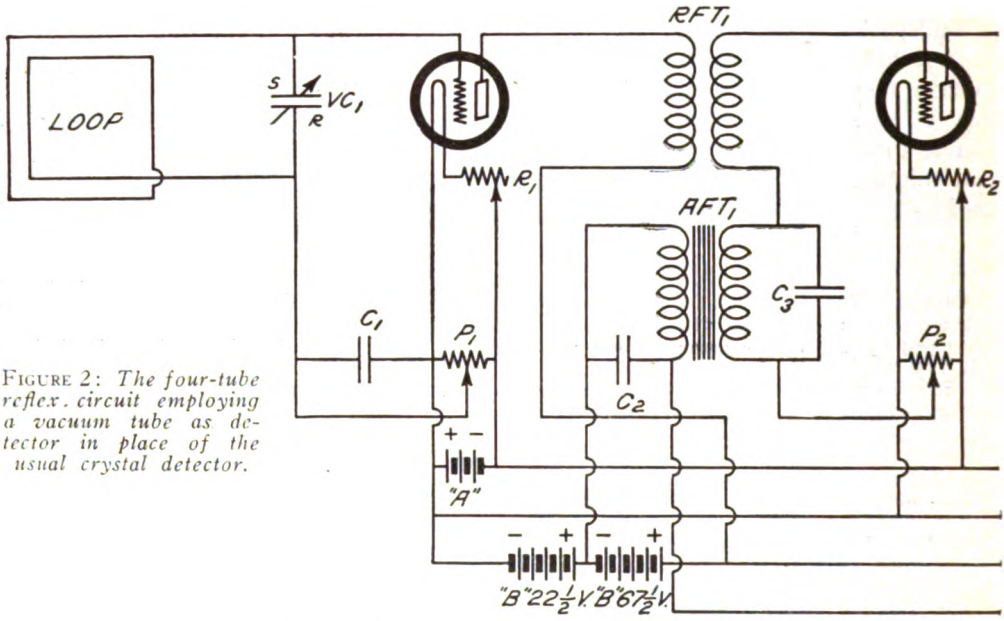

FIGURE 2: *The four-tube reflex circuit employing a vacuum tube as detector in place of the usual crystal detector.*

QUESTION: In the July issue of POPULAR RADIO you printed a circuit (Figure 4, page 78) showing three stages of radio, two stages of audio-frequency amplification, and a crystal detector, with three vacuum tubes. This reflex circuit works fine on a loop antenna, but I don't like the bother of "setting" the crystal detector in adjustment all the time. Will you please show me how to add a vacuum-tube detector in place of the crystal? I have tried it but have had no success, so I thought I had better come to headquarters and get the correct information. ROWLAND BATES

ANSWER: The four-tube reflex circuit shown in the diagram in Figure 2 gives you the information that you require. Exactly the same parts are used that were contained in the old crystal circuit, except for the vacuum tube, which replaces the crystal, and a grid leak GL, of 2 megohms resistance, a grid condenser GC, of .00025 mfd. capacity, and an additional rheostat. Four C-301-A tubes or UV-201-A tubes, or DV-6-A tubes may be used with good results.

* * *

QUESTION: Is a power amplifier much different from an audio-frequency amplifier? JACK ROCHE

ANSWER: Both of the types of amplifiers known by the popular names you mention are really audio-frequency amplifiers. The power amplifier is an audio-frequency amplifier that uses larger tubes than ordinarily used in the regular audio-frequency amplifiers attached to a radio receiving set. This means that it is necessary to employ higher plate voltages and also a "C" battery to keep the grids of the tubes at the correct free potential for proper operation.

Some types of power amplifiers use two tubes for each stage. These are connected "back-to-back" with a special split-winding transformer so that the cores of the transformers are not saturated when no signal is being received.

* * *

QUESTION: I want to use the electric light lines for an antenna as I cannot put up an outdoor installation. What kind of a device or instrument is used for connecting to the electric lamp sockets? Do they work well?

S. N. SMITH

ANSWER: The part you must ask the dealer for is an electric light adapter. There are a number of these devices on the market with various trade names, but the dealer will understand if you ask him for an adapter to use the electric light circuit for an antenna.

These devices do not work with the same efficiency in all locations. In some houses they will not work at all. However, it is worth trying if you can not put up any other kind of antenna.

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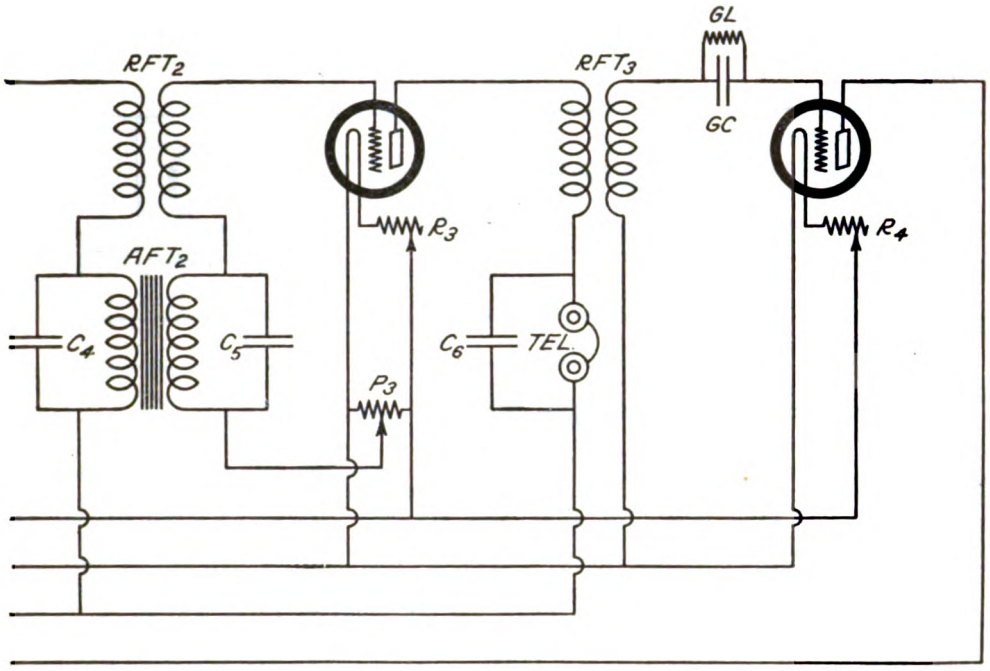

QUESTION: What sized motor generator should I buy to operate two 250-watt G. E. transmitting tubes, one as an oscillator and one as a modulator with a 50-watt speech amplifier?

R. M. H.

ANSWER: You will need a one-kw. machine at least.

* * *

QUESTION: Which is the best for local reception, a crystal set or a vacuum-tube set?

THOS. J. GREGG

ANSWER: They both have their advantages and disadvantages. The crystal is the simplest and the cheapest but it will not bring in the signals as loud as the vacuum-tube set. Although the vacuum-tube set *is* more expensive, it will be found to be more reliable and the detector action is permanent; there is no adjustment of the vacuum tube to sensitivity as in the case of the crystal and it is not knocked out of adjustment. For all around use the vacuum-tube set furnishes the more reliable and efficient service.

* * *

QUESTION: Will it be feasible to use a gas pipe as a ground for my receiver? I will have to run a wire about fifteen feet if I use a water pipe.

JAMES CULBERT

ANSWER: The gas pipe will not be good. Use the water pipe even if you have to run fifty feet to get to it.

* * *

QUESTION: What is the best way to control the regeneration in an ordinary ultra-audion circuit? Should I use a variable grid condenser or would a variable bypass condenser across the telephones and "B" batteries be better? Or should I use both? I know that the filament rheostat plays an important part in the proper control of this simple circuit but I want to get your views on the subject.

RAYMOND NILES

ANSWER: With a fixed condenser in the grid circuit and a variable condenser used in the plate circuit as a bypass across the telephones, you should get the best results. Varying the grid condenser will also do the same thing but when the grid condenser is varied to a rather high capacity, the tuning may become broadened and at the same time the regenerative control will become "sticky;" that is, it will burst into oscillation and you will have to reduce the capacity of the condenser to a low value and work up again. The variable plate bypass condenser is much the better of the two.

The filament need only be set at approximately the right value and all the control work done with the variable.

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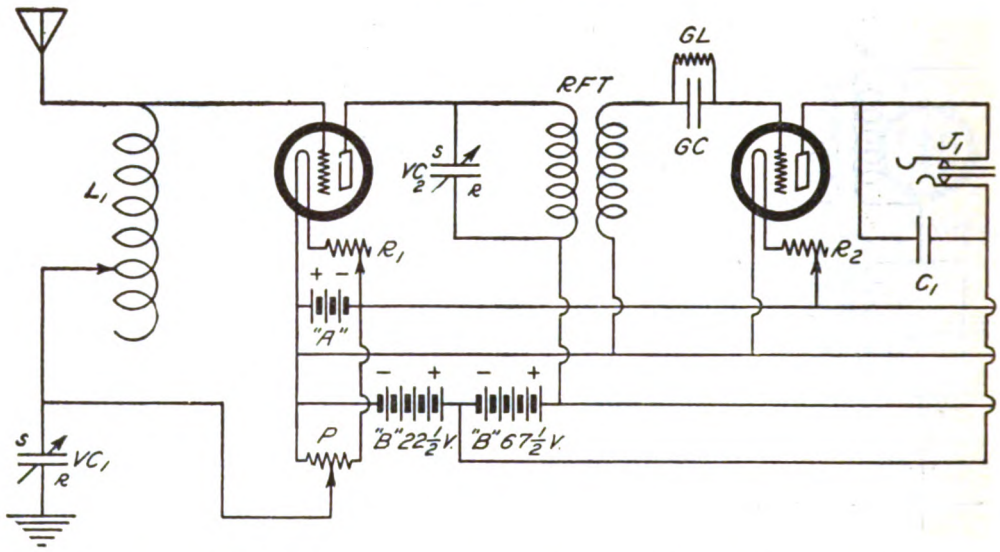

QUESTION: Will you kindly give me a hook-up for connecting the following apparatus in a circuit for one stage of tuned radio-frequency amplification, detector and two stages of audio-frequency amplification? The parts are:

1 Variable inductance.....(L1)
2 General Radio variable condensers, .001 mfd.....(VC1 and VC2)
3 UV-201-A vacuum tubes (amplifiers);
1 UV-200 Vacuum tube (detector);
1 Framingham potentiometer....(P)
1 R. M. C. radio-frequency transformer .....(RFT)
1 Dubilier combination grid condenser and leak.....(GC and GL)
3 Amsco filament rheostats, 20 ohms .....(R1, R3 and R4)
1 Amsco filament rheostat, 6 ohms .....(R2)
2 Cardwell amplifying transformers .....(AFT1 and AFT2)

Are there any other parts I will need?

JOSEPH D. HADDON

ANSWER: The circuit is given in Figure 3. You will also need a mica fixed condenser, C1, of .0005 mfd. capacity for shunting the primary of the transformer AFT1, and two double-circuit and one single-circuit jacks, J1 and J2, and J3, respectively.

The antenna tuning is accomplished by varying the inductance of L1, and the capacity of VC1.

The radio-frequency transformer is tuned by the variable condenser VC2. This really tunes only the plate circuit of the first tube but the two coils of the transformer RFT, are so closely coupled that this really forces the tuned signals into the secondary winding. The circuit is a good one.

* * *

QUESTION: From which will I get the most sensitivity, a straight regenerative circuit using only one tube, or a non-regenerative circuit using one stage of radio-frequency amplification and a detector, with two tubes? What are the outstanding features of both methods, and which of the two would be the easiest to operate from the standpoint of the layman who does not know the delicate tricks of tuning?

D. FALSTER HOFFMAN

ANSWER: This is a matter of opinion which has not yet been satisfactorily settled. There are so many different radio-frequency systems, and they all have their advantages and disadvantages when considered from various viewpoints, that it is hard to rate radio-frequency amplification under any one set standard. Regeneration, however, is, without doubt, the most efficient method of combining radio-frequency amplification and detection in one tube. It has the disadvantage (in the hands of an inexperienced operator) of sending out interfering waves, if the set is too closely coupled with the antenna circuit, or, if not controlled properly, it may not be brought up to the most efficient operating point. The more recent re-

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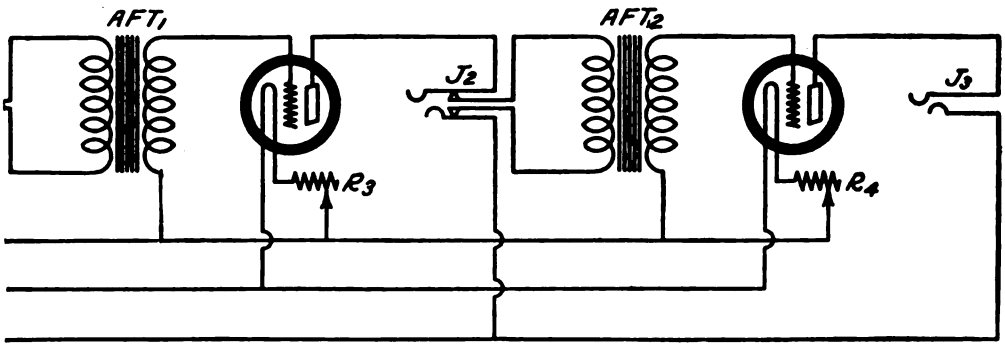
FIGURE 3: *One stage of tuned radio-frequency amplification, detector and two stages of audio-frequency amplification. This is a real reliable distance getter.*



generative circuits that employ looser coupling and simpler regenerative control go a long way to overcome these difficulties while at the same time retaining all the good advantages of the older circuit arrangements, and in some cases they produce even better results.

Radio-frequency amplification, however, although more tubes are used and although it is harder to tune, has its own advantages, especially the newer types of inductively tuned radio-frequency circuits employing compensating condensers which keep the circuits from falling into oscillation by preventing any feedback of high-frequency energy through the capacity of the tubes themselves. These newer circuits are extremely favorable to long-distance reception on a loop antenna, and the signal-static ratio on such a receiver is considerably increased.

For a given number of tubes, the regenerative method is undoubtedly the peer, but where unlimited radio-frequency amplification is necessary, there is no other way out but to use cascade radio-frequency amplification at the wavelength of transmission, or by some method similar to the super-heterodyne in which the signal is changed to a lower frequency and then amplified with greater efficiency than is now possible at the higher frequencies.

* * *

QUESTION: I am located among the tall buildings of a large city, and am only one half mile from the largest broadcasting station in this section of the country. When this station is working I am, at present, unable to hear anything else. And yet I am using the regular regenerative circuit with a variocoupler and two variometers, which, I was given to understand would tune out anything.

At any rate I am unable to do it, so will you kindly let me know of some circuit, reflex, neutrodyne, Flewelling, four-circuit, or anything, which should enable me to get some of the other local stations, at least.

I can hear the other stations with my present set, but they are "in the background and always overpowered by the station first spoken of.

Would the four-circuit tuner be the right thing to use? The circuit appeals to me.

HARRY Z. MENDEL

ANSWER: The four-circuit tuner will do the work you require. This is because of the extremely low decrement of the circuits used and the loose coupling employed. Be sure to use coils which are wound on composition tubing of good quality and be sure that there is no shellac or any other kind of insulating paint used on the windings; otherwise even this circuit will tune too broadly.

* * *

QUESTION: How many volts should be used on the plates of the C-301-A tubes when they are used as amplifiers?

S. BENNINGTON

ANSWER: Not more than 90 volts, unless "C" batteries are used. You may use up to 120 volts if you use a "C" battery of 9 volts on the grids of the amplifiers.

* * *

QUESTION: What capacity of condenser is used in the secondary circuit of the Haynes type receiver? I want to get a Cardwell condenser for this set and I do not know what size to ask for.

ALLEN AIRES

ANSWER: The correct capacity is .00025 mfd.

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Radio Renders Heroic Service to Humanity

No more impressive evidence of the inestimable value of radio in the hour of emergency for summoning aid when moments were priceless and in broadcasting warnings when those warnings saved human life, can be offered than in the earthquake calamity in Japan early in September. A part of this service is told here:

The calamity which practically wiped out Tokyo and Yokohama and broke the Pacific cable, gave radio another opportunity to demonstrate to the world its value in international communication, especially in emergencies when land lines and cables fail. Without the single radio communication link left at Iwaki the world might have been without details of the Japanese disaster for as long as a week. Bits of news and imperative information would have been put through by cable, but radio is said by Secretary Hoover to have literally saved the day in bringing in relief as well as in carrying out the news.

To be sure, the first brief message of the disaster came to the Japanese Ambassador at Washington by cable from Nagasaki *via* London—out of the back door of the East, as it were, and over cables estimated 15,000 miles long. The commercial cable from Japan to Bonin Island (reported submerged) and thence to Guam, was put out of service by the earthquake, so that messages were routed east by way of Manila, Shanghai and Nagasaki, or west by way of London.

It remained for radio to carry most of the official dispatches and news reports across the Pacific to North America, and radio, aided by the remaining cable connection of Nagasaki handled a tremendous amount of traffic. The Japanese government station at Iwaki, or Tomioka, stepped into the breach and the world now knows of the excellent service rendered by the Japanese operator who stood a long watch alone. His call and messages on the disaster were picked up by the Radio Corporation's station at Bolinas, California, and were relayed to all points in the United States. Iwaki, which is about 144 miles from the stricken cities, for some time had no means of communication inland; at the suggestion of the Japanese Ambassador at Washington, however, a courier service was established to Tokyo and a regular schedule was put in operation. A statement that "communication was open to Tokyo" by the State Department, led some to believe that line wire communication between the station and Tokyo was established, yet no wires had been re-established. Since the advent of radio, it seems that a new word must be substituted for "communication" when referring to roads and other lines of transportation.

Radio was the means of getting the first authentic account of the disaster to the new world on September 4, when the master of the *S. S. President Jefferson* radioed to his Shanghai office from the port of Yokohama direct. The American Consul put the message on the cable for Secretary Hughes in Washington, where facts relating the unsafe condition of the harbor at Yokohama were immediately broadcast by the Naval Hydrographic Office, so that all ships might be warned of the hidden dangers there owing to the absence of lights.

The U. S. Naval forces in Japanese waters also rendered official emergency service by radio. The American Asiatic fleet was at Yokohama and the Destroyer *Borie* was stationed at Nagasaki as a radio relay ship. Messages from the American flagship were picked up by the *Borie*, relayed to the Naval radio station at Cavite and thence to the Naval station at San Francisco. Government west-bound messages were sent from Washington *via* the Annapolis radio station or commercial land lines to San Francisco, where they were relayed *via* Honolulu, Guam and Cavite to the *Borie*

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and thence to the American fleet off Yokohama. The *U. S. S. Sacramento* was stationed at Woosung, China, to relay radio messages. The naval service delivered official dispatches to Yokohama within twenty-four hours.

Many radio experts feel that the terrible disaster and the severing of communication out of Japan will aid materially in establishing better radio service between Nippon and the world. The policy of the Japanese government has been to control radio, although American commercial companies have been endeavoring to provide better stations and transmission for some time. It is now hoped that American radio interests will be given the opportunity to establish high-powered stations in Japan.

—Carl H. Butman

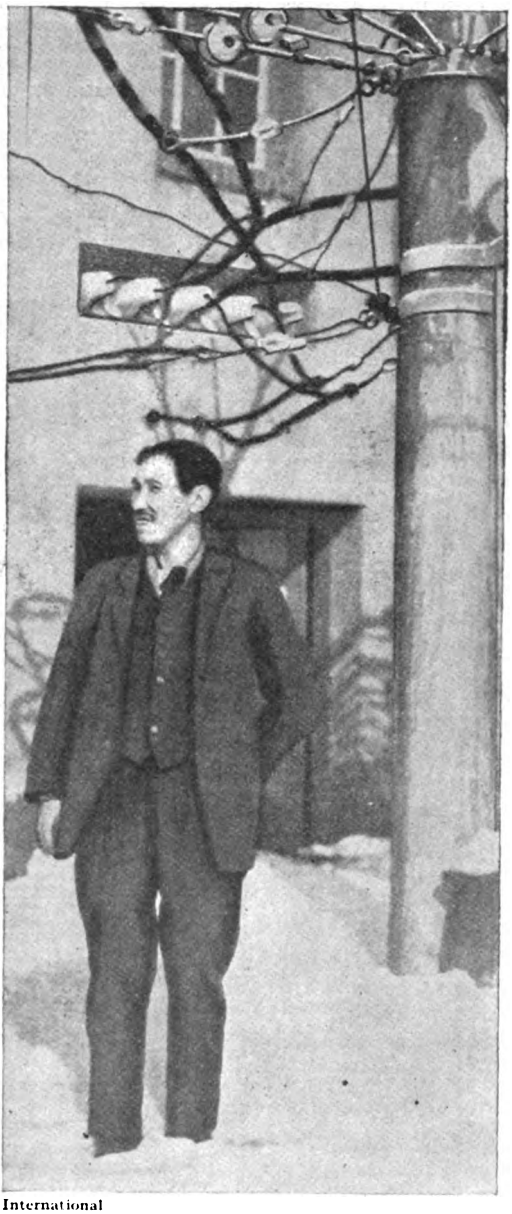
The Bureau of Standards to Transmit Radio-Frequency Signals

The Department of Commerce has announced a schedule of standard frequency radio signals to be transmitted by the Bureau of Standards for the months of October, November and December. These signals should be of interest to all transmitting station operators in checking wavemeters and adjusting transmitting and receiving apparatus; their accuracy is better than three-tenths of one percent. The full announcement follows:

Commercial and ship operators should be especially interested in the transmission of October 20. The signals of November 20 cover approximately the same band as those of October 20; the signals of November 5 cover the frequency band used by "Class B" broadcasting stations. The frequencies transmitted on December 5 cover those used by all broadcasting stations as well as some used by amateurs.

Measurements made at the bureau of the frequencies on which broadcasting stations are operated indicate that some stations are not remaining on their assigned frequencies, hence are causing interference with programs from their own as well as other broadcasting stations.

The schedule followed in these transmissions will be slightly different from that followed in the past. All transmissions will be by unmodulated continuous-wave telegraphy and no announcement will be made by voice. This considerably reduces the time of transmitting any one frequency. The signals will in other respects be similar to those transmitted in the past. A complete frequency transmission will include a "general call," a "standard frequency signal" and "announcements." The "general call" will be given at the beginning of the eight-minute period and will continue for about two minutes. This will include a statement of the frequency. The "standard frequency signal" will be a series of very long dashes



International

THE RADIO ENGINEER WHOSE STATION SUMMONED AID TO JAPAN

Mr. Wakamatsu was the radio expert in charge of the Haranomachi branch of the Tomoka radio station that for a few fateful hours was the only link between the devastated areas and the rest of civilization. The remarkable concrete antenna towers, 660 feet high, were designed by the Japanese scientist F. Omori for the express purpose of withstanding earthquake shocks; to his genius is largely due the help that was summoned in time to save countless human lives.

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with the call letters WWV intervening. This signal will continue for about four minutes. The "announcements" will be on the same frequency as the "standard frequency signal" just transmitted, and will contain a statement of the measured frequency. An announcement of the next frequency to be transmitted will then be given. There will then be a four-minute interval while the transmitting set is adjusted for the next frequency.

The complete schedule has been so planned that a wavemeter may be accurately calibrated over a range of from 150 to 1,700 kilocycles, if all of the transmissions are received. With sensitive receiving apparatus it should be possible to receive these signals anywhere east of the Mississippi River.

The complete schedule of standard frequency signals to be transmitted follows:

Schedule of Standard Frequency Transmission from WWV

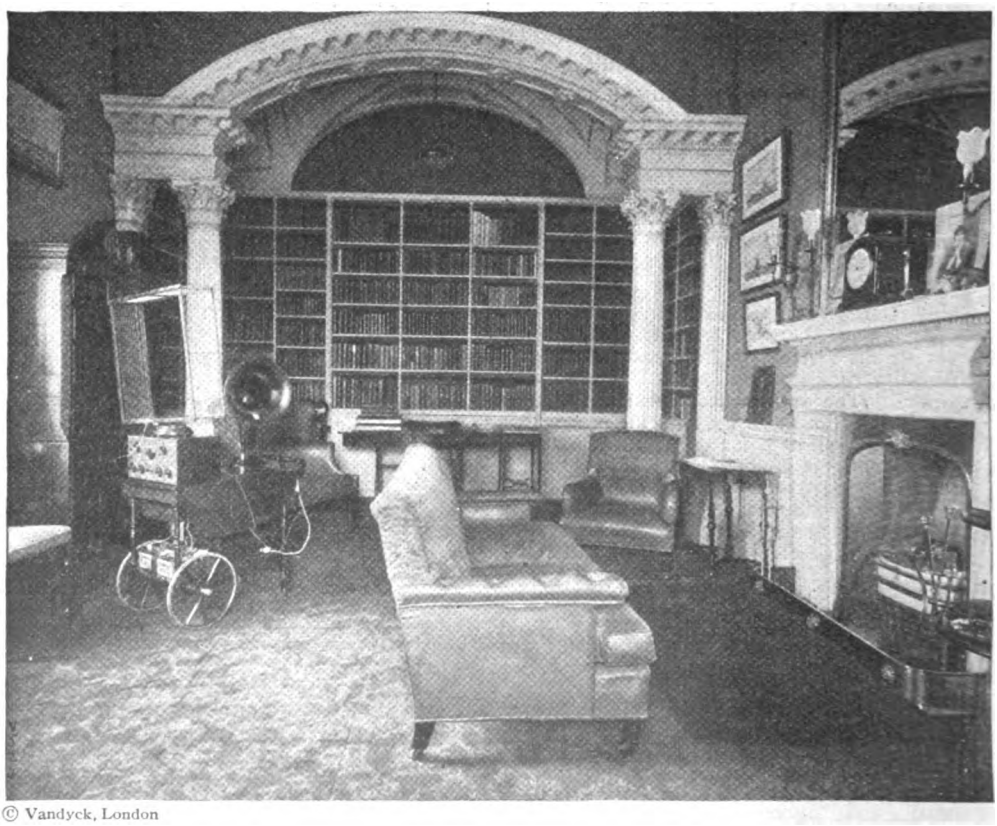
Wavelength in meters is given in parentheses.

Eastern Standard Time	OCT. 20	NOV. 5	NOV. 20	DEC. 5
	166.5	Kilocycles 500	150	500
11.00 to 11.08 P.M...	(1800)	(600)	(1999)	(600)
	220	580	190	700
11.12 to 11.20 P.M...	(1363)	(517)	(1578)	(438)
	275	640	240	900
11.24 to 11.32 P.M....	(1090)	(468)	(1249)	(333)
	315	700	290	1100
11.36 to 11.44 P.M...	(952)	(428)	(1034)	(273)
	375	760	360	1300
11.48 to 11.56 P.M...	(800)	(394)	(833)	(231)
	425	833	430	1500
12.00 to 12.08 A.M...	(705)	(360)	(697)	(200)
	500	920	500	1600
12.12 to 12.20 A.M...	(600)	(326)	(600)	(187)
	666	1,000	570	1700
12.24 to 12.32 A.M...	(450)	(300)	(526)	(176)

A Long-distance Watch Tick

AUDIENCES that have been held so spellbound in the theater that they could "hear the ticking of a watch" may have to change a time-worn expression that is being made obsolete by radio. Here is an account of a watch tick that was heard hundreds of miles:

Listeners-in had a new and odd experience recently when they heard the ticking of a



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WHERE ROYALTY LISTENS IN

When His Royal Highness, the Duke of York, democratically wants to join the growing army of radio "hams" in England, he merely directs his butler to wheel in his portable radio set—shown above in the duke's sitting room.

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Gilliams Service

AN EXTRAORDINARY MECHANICAL CODE WRITER

This machine, invented by Dr. Scherbius, a noted Austrian electrical expert, is capable of 22,000,000,000 code combinations. It may be operated by any typewriter and is capable of writing code messages as they are received by wire or radio and deciphering them automatically.

watch that was held near one of the microphones on the stage of the Municipal Theater in Forest Park, St. Louis, while the operetta *Die Fledermaus* was being broadcast by station KSD. The watch episode was in the second act. Craig Campbell, in the role of Eisenstein, exhibits a lady's watch to a masked woman whom he meets at a gay party. She is his wife, but he does not know it. He playfully counts her pulse while timing the beats with his watch. While doing this Campbell held the watch close to the microphone. Several St. Louisans reported that they distinctly heard the ticking of the watch over their sets and there is no reason to doubt that it was heard at more distant points.

—Edward O'Connor

A Radio Net Around the Arctic Circle

SOME idea of what the long arm of radio may mean to the out-of-the-way places of the world which have been deprived in a large measure of the benefits of civilization, may be derived from this brief description of the extending use of wireless into the waste lands of the far north:

A plan has been adopted by the Canadian government by which Dawson City, of Klondike fame, is to be linked with civilization by radio. Stations will be established at Dawson City, Fort Simpson, and Fort McMurray, constituting yet another step in the taming of the far north. Some idea of the distances involved will be had when it is noted that Dawson is only three hundred miles from the Arctic circle. Heretofore the only electric connection that Dawson City has had with the south, has been by telegraph with Ashcroft, British Columbia. The first of the connecting stations, Fort Simpson, is on the Mackenzie River, in the Northwest Territories; the second, and most southerly, is in the province of Alberta, on the Athabasca River. These stations will be installed this summer.

Next year stations will probably be established at Forts Smith, Resolution, Norman, and Aklavik, thus completing the chain of communication in northwestern Canada.

—K. H. Broadus

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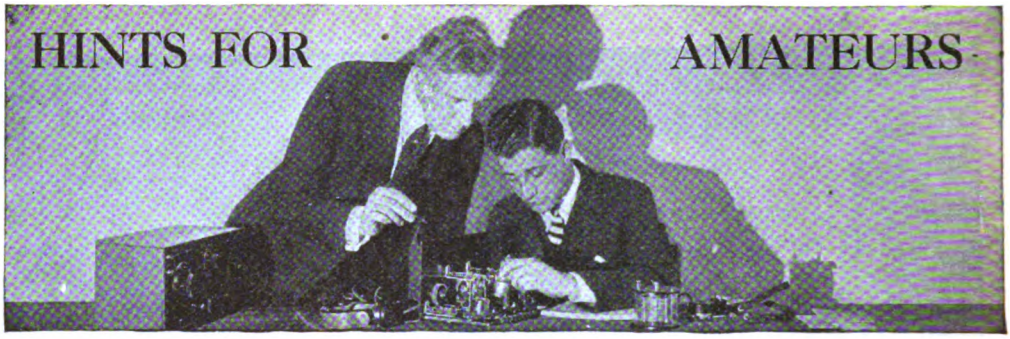

Don't skip any articles in this magazine. They have all been carefully chosen to give the reader the proper perspective of the radio art, and to keep him well informed not only of new scientific developments that mean progress, but of new problems and conditions that confront the radio world, and how they are being solved and overcome.

So, just because you do not have as much of an interest in one subject as in another, do not skip. You will really be missing something that will help you to the right viewpoint. If you do not agree with the other fellow on a certain subject, by reading his argument or discussion you will at least be able to understand how he thinks, while at the same time making your own logical conclusions. Some of the ideas may seem too deep for you, just as some of them may seem too simple, but if you study his views, the deep ideas will finally become clear and understandable and the simple ideas will be of interest just because you know they are true.

You really cannot afford to skip a single item!

* * *

In making the hoops for supporting the wires of a cage antenna it will be found that No. 00 hard-drawn copper wire will be suitable. Bend a piece of this wire into the proper-sized circle and solder the two ends together (flush) with hard solder. Then you can mark off the proper spacings for the wires by notching with a file. The antenna wires should be wrapped around each hoop with a single turn and soldered firmly in place with the same hard solder.

If this is done the cage will be absolutely permanent.

* * *

When you finally *do* go to bed at night, after listening-in all evening (possibly well on into the morning) are you happy but tired and worn out? Well, then, your "A" battery may feel the same way, and it is a good plan to turn on the charger so that the battery may rest and recuperate while you retire and do the same thing. There is nothing like keeping a battery up to full charge to add to its life. A fully charged battery will also be a great help in enabling you to tune in and hold those long distance signals.

* * *

One dead "B" battery connected in the plate circuit of a receiving set will make you think that there is a lot of static in the air and at the same time make you believe that the set has "gone wrong." Always test your "B" batteries with a small high-resistance voltmeter.

* * *

Keep the terminals of the storage battery coated with a thin coat of vaseline and always be sure that no green, gray, or yellow substance is allowed to collect on them. This will corrode the clips or the copper wire which connects the battery with the set and may often cause noises in the set.

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THERE is no fault in a receiving set that is as bothersome and which will last as long without the operator finding out how to eliminate it as the existence of "body capacity."

Body capacity in a receiving set causes the wavelength, to which the set is tuned, to vary when the operator's hand is brought near to or taken away from the tuning dials. In such a case, the operator may have tuned in a distant station, and when he takes his hand away from the dial, the signal will have faded out; if he brings his hand near the dial again the signal will come back in again. So much for body capacity; it is a decided nuisance, and takes the pleasure out of DX hunting.

It may be easily avoided, however, by one of two methods of shielding. One method would be to place a copper sheet on the back of the panel, between the panel and the instruments. The sheet should be grounded.

The better way, would be to place the part (the shafts) of the condensers and variable tuning instruments which face the front of the panel or project through the panel into the knob at ground potential, or at ground potential as far as the radio-frequency currents are concerned.

Therefore, in all of the diagrams which will be published in POPULAR RADIO, the proper way to connect the variable-inductive or variable-capacitative instruments will be shown. The rotating coils or rotating plates will be designated as R, and the stationary coils or plates will be shown as S.

The symbol for the variable condenser will therefore be as shown at A, in Figure 1, and the variable inductance (variometer) will be as shown at B.

* * *

Do not leave kinks in your telephone cords, as this will finally allow them to wear through the fine braided wire and result in a loose connection. Make a practice of untwisting the cords each time you put the telephones on your head and the cords will last a much longer time.

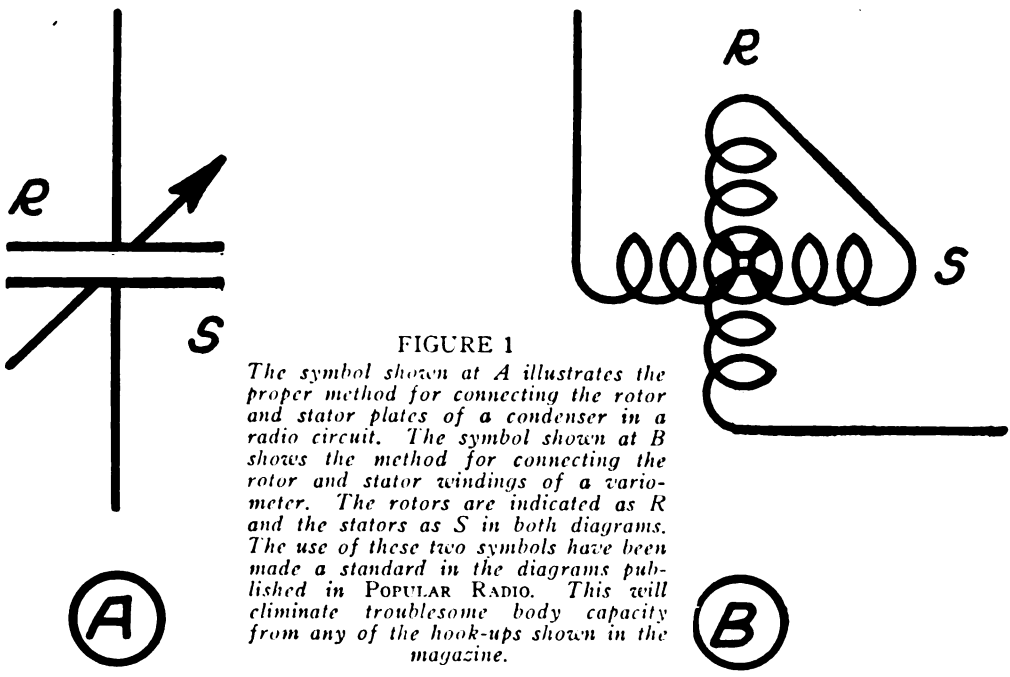

FIGURE 1

The symbol shown at A illustrates the proper method for connecting the rotor and stator plates of a condenser in a radio circuit. The symbol shown at B shows the method for connecting the rotor and stator windings of a variometer. The rotors are indicated as R and the stators as S in both diagrams. The use of these two symbols have been made a standard in the diagrams published in POPULAR RADIO. *This will eliminate troublesome body capacity from any of the hook-ups shown in the magazine.*

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THIS *department will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.*

FIGURE 1: No. 1,458,949. CARRIER RADIO-TELEPHONE SYSTEM. Invented by *Harold W. Nichols,* Maplewood, N. J:

The primary object of this invention is to provide a carrier system which is both efficient and economical. Another object is to provide means whereby a pure modulated wave and energy of the fundamental carrier frequency may be transmitted from a signal station. Other objects will be apparent to those skilled in the art from a reading of the patent, copies of which may be obtained from the Government printing office.

FIGURE 2: No. 1,458,466. ANTENNA SELECTOR SWITCH. Invented by *Alfred Crossley,* Washington, D. C.

The object of this invention is to provide a practical selector switch capable of rapid manipulation to connect various combinations of underground, elevated or loop antenna to the receiving apparatus. Another object is to provide means for insuring perfect electrical contact of the switch elements.

FIGURE 3: No. 1,454,307. RADIOTELEGRAPHY. Invented by *Adrien L. Anderson,* Palo Alto, Calif.

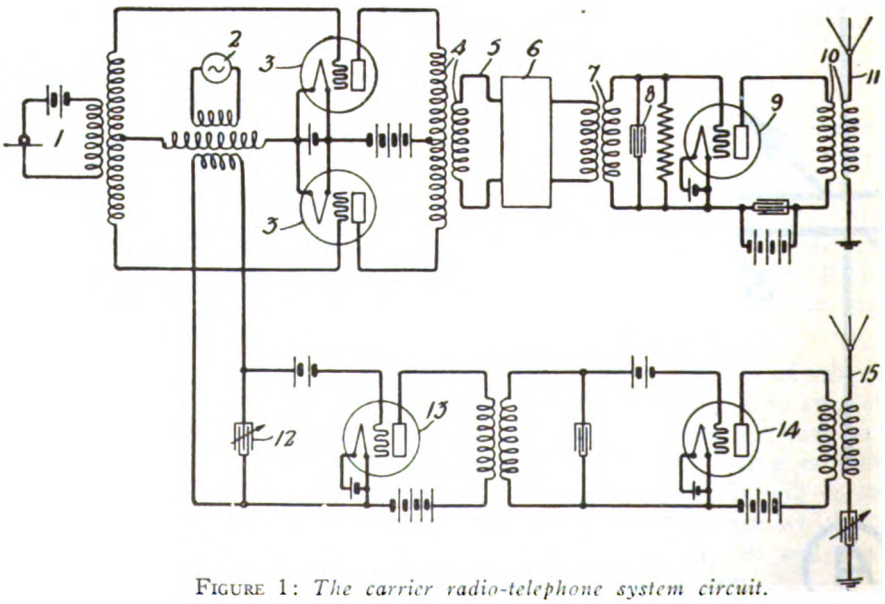

FIGURE 1: *The carrier radio-telephone system circuit.*

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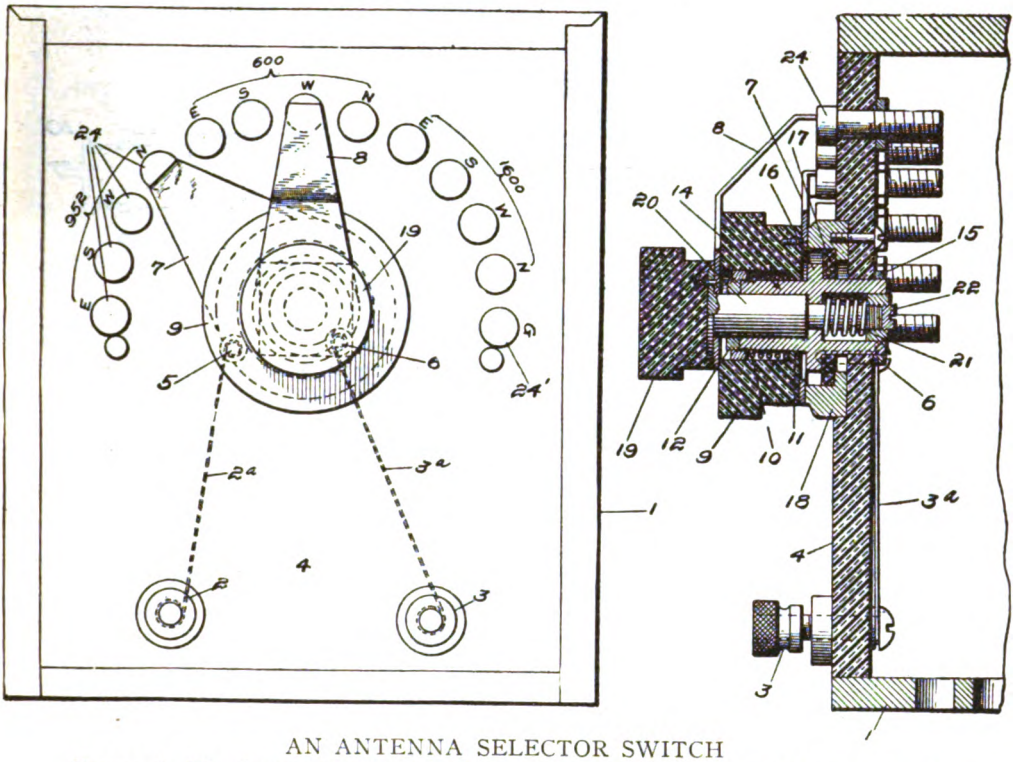
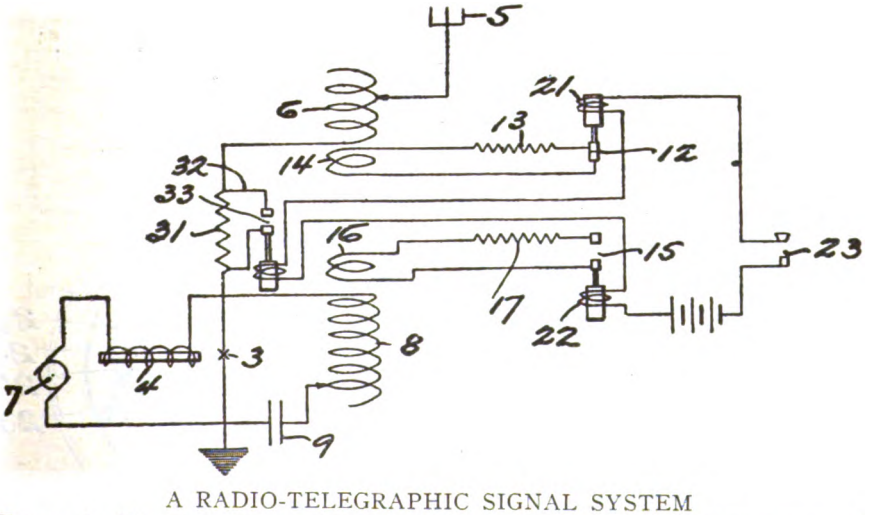


AN ANTENNA SELECTOR SWITCH

FIGURE 2: *The front and side elevations of the selector switch which is designed for automatically changing connections to various antenna systems.*



A RADIO-TELEGRAPHIC SIGNAL SYSTEM

FIGURE 3: *The circuit of the new system for signaling with a single wave. It uses an arc transmitter, with an automatic keying device to produce telegraphic signals without any of the familiar backlash of the old system.*

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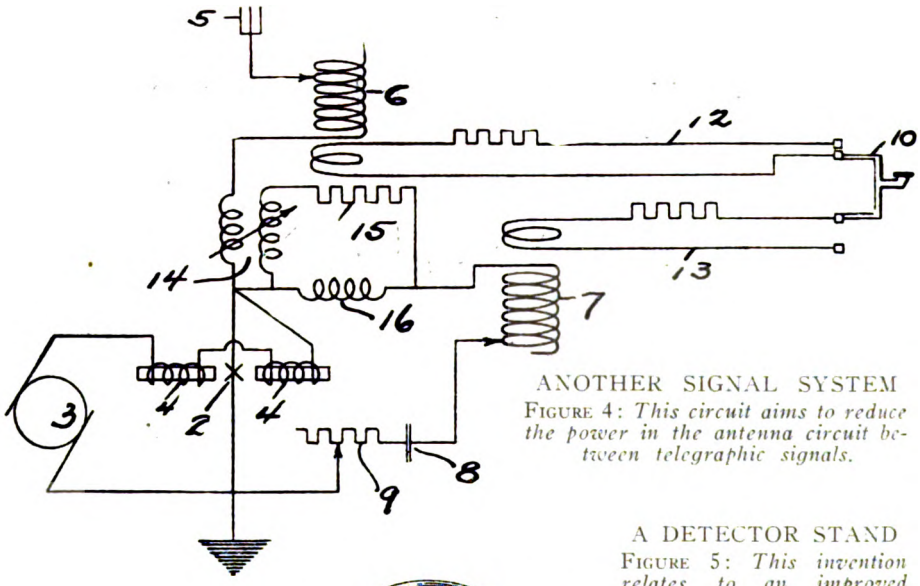
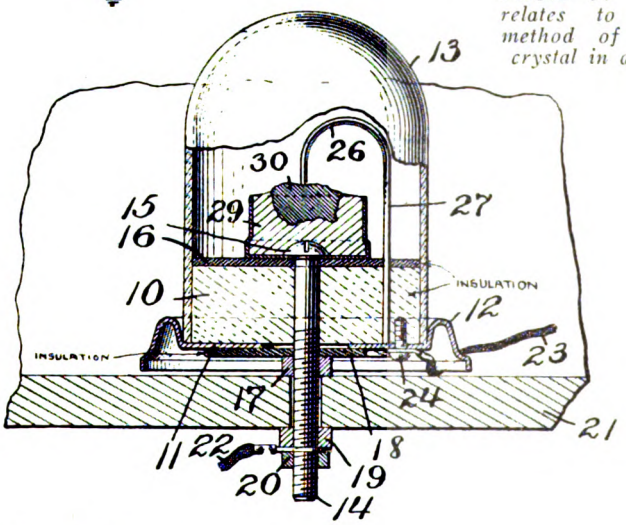


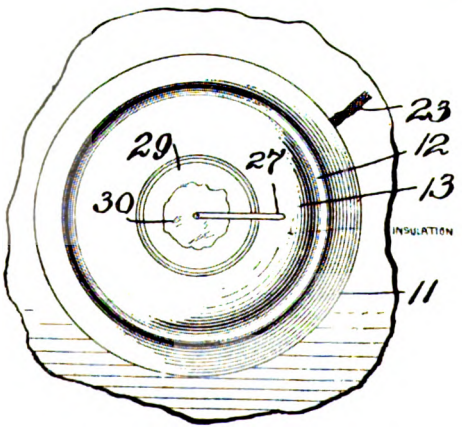
ANOTHER SIGNAL SYSTEM

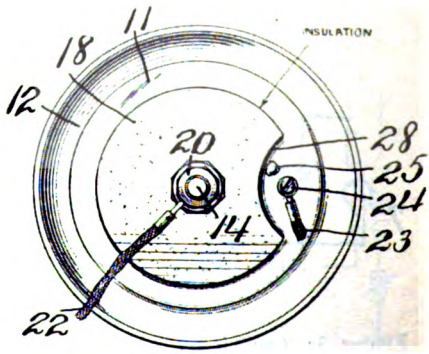
FIGURE 4: *This circuit aims to reduce the power in the antenna circuit between telegraphic signals.*

A DETECTOR STAND

FIGURE 5: *This invention relates to an improved method of adjusting the crystal in a receiving set.*







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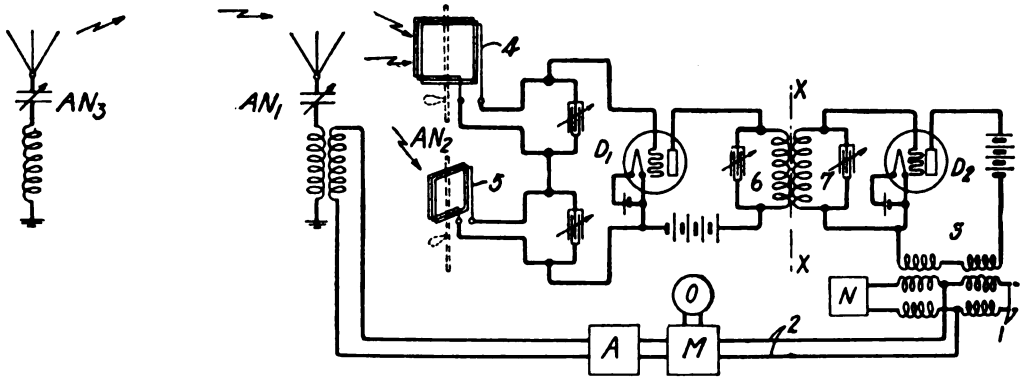

A NEW RECEIVING CIRCUIT

FIGURE 6: *The Mills circuit which includes a means for impressing an auxiliary radio carrier on the detector circuit without impairing reception.*

This invention relates to radio telegraphy and particularly to radio-telegraphy transmission systems. Its object is to provide a single-wave radio signaling system.

FIGURE 4: No. 1,454,630. RADIO TELEGRAPHY. Invented by *Harold F. Elliott,* Palo Alto, Calif.

This invention relates to radio-telegraphy signaling systems and particularly to single-wave signaling systems in which the source of oscillations is connected to the antenna circuit and to a local oscillating circuit, the electric constants of the two circuits being such that the oscillations may be caused to prefer one circuit to the other. Systems of this nature are particularly advantageous in continuous undamped-wave signaling, in which the source of oscillations is an arc or other continuous undamped-wave generator. In systems of this type, the current in the antenna is reduced to relatively low values during the intervals between the dots and dashes of the signal.

It is the object of the invention to reduce the magnitude of the residual current in the antenna during such intervals to smaller values. The invention possesses other advantages, some of which are set forth in the patent.

FIGURE 5: No. 1,454,997. CRYSTAL DETECTOR. Invented by *Gaetano Greco* and *Karl G. Wolff,* Newark, N. J.

This invention relates to an improved crystal detector for radio receiving sets. It is adapted to be placed in position in a set and is easily accessible for adjustment.

FIGURE 6: No. 1,457,447. RADIO RECEIVING CIRCUITS. Invented by *John Mills,* Wyoming, N. J.

This invention relates to radio receiving circuits, particularly to that type employing the principle of successive detection.

The principle object is to provide a means whereby, in an intermediate-frequency receiving circuit, a regulable amount of auxiliary radio carrier-wave may be impressed on the input circuit of the first detector without detriment to reception from the distant station.

Do Ether Waves Cause Gravitation?

SCIENTISTS *are coming to believe in the existence of a new kind of ether wave—the remarkable ultra-X rays. Knowledge of them may solve some fundamental scientific mysteries. The latest developments in this amazing field of research will be told in* POPULAR RADIO *for December.*

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ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

No Danger of Hypnotic "Spells" Sent Out by Radio

THE instances reported recently in which patients in hospitals and elsewhere have been hypnotized by radio do not involve, say the scientists, any new or startling scientific principle. Once a person has been hypnotized by a certain hypnotist and has become accustomed to the control of that individual the hypnotic trance can be induced later without the personal presence of the hypnotist. A written note, words spoken over the telephone, even a definite message sent by the hypnotist and repeated to the patient by a third person are sufficient to restore the hypnotic control. It is quite natural that words spoken by radio and heard by the patient at a listening apparatus will have the same effect. Such hypnotic messages are effective, of course, only on the patient who has been accustomed to being hypnotized by the particular hypnotist who is sending out the message. There is no danger, the experts assure us, that any kind of "spell" sent out over the radio would affect listeners other than the particular person for whom the message was intended.

* * *

A Bug that Eats Lead Cables

ONE of the most curious troubles encountered by the electrical engineer has turned up in California. The name of it is *Scobicia declivis*. This is not a disease; it is the name of a variety of beetle. With plenty of food available in the fruits and vegetables for which the Golden State is so famous this perverse bug delights to gnaw the lead coatings of telephone cables. He bores little holes through the lead and presently rain water gets in and causes a short circuit. The damage done is so serious that the United States Bureau of Entomology at Washington has been asked to help devise a remedy.

* * *

Snake Doctoring by Radio

IN England recently one of the "uncles" who broadcast talks on snakes (all of the English broadcast talkers seem to be uncles) received next morning a letter from a small boy requesting a diagnosis of a snake, carefully described, which said small boy had captured in the paternal garden. The description showed the snake to be extremely poisonous and a message was broadcast immediately advising the captor to watch his step, or rather to watch the snake.

* * *

What an Electrical Wizard Is Worth to the Country

THE direct money value of Mr. Edison's inventions to the persons who have invested in them has been computed by a writer in the *New York Times* as $15,599,000,000. Even this staggering sum is incomplete for it does not include the much larger indirect values created by the electrical industries based on Mr. Edison's ideas and inventions.

* * *

Can Static Be Used as a Fertilizer?

RECENT careful tests in Iowa reported in the *Chemical News*, confirm the earlier idea that a good deal of nitrate, valuable for fertilizer, is being produced all the time in the air and falls to the earth dissolved in rain and snow. The nitrate is supposed to be formed in the air out of nitrogen gas by means of sparks and other discharges of atmospheric electricity, either the great sparks of lightning or smaller imperceptible ones around dust particles or rain drops. It is these same atmospheric discharges which are believed to be responsible, in part at least, for radio disturbances. Perhaps static may have a very practical use in the world after all if it assists in adding nitrate to the soil.

* * *

Broadcasting a $10,000,000 Lecture

TWICE recently Dr. Russell H. Conwell of Philadelphia has broadcast his lecture "Acres of Diamonds," a lecture familiar to two generations of lyceum and Chautauqua attendants all over the country which has earned for Dr. Conwell more than ten million dollars, nearly all of which he has spent in the cause of popular education.

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Education by Radio

IT seems possible that radio broadcasting may prove to be the solution for the vexed question of popularizing the facts and viewpoint of science. A short, interesting scientific talk, received at home over the radio set, will attract many listeners who never could have been persuaded to wade through scientific books or to attend a two-hour lecture at the university. During the past few months the New York Section of the American Chemical Society has been broadcasting short chemical talks once a week over WJZ. WEAF will soon broadcast some of the extension courses of Columbia University. A radio lecture on accountancy was received recently in a New York high school. These mark the beginnings of what must soon be a powerful instrument of national education.

* * *

Scrambling the Program for Outsiders

IN England, where all broadcasting is a monopoly of a single company authorized for this service by the government, there has been patented an ingenious system of preventing unauthorized outsiders from listening-in by means of pirated or "bootleg" sets. This system adds to the carrier wave, in addition to the modulation of the regular program, a mass of confused tones and signals sufficient to obscure the program altogether. Authorized subscribers to the service are then supplied with specially designed filter coils, which may be changed from time to time, and which have the effect of removing the "scrambled" signals.

* * *

Are There Martians for Us to Reach by Radio?

EVER since the announcement of the supposed radio signals from Mars (though these signals turned out to be without any probable connection with that planet) the old scientific problem of the habitability of Mars has been of interest to the radio fan. The newest piece of scientific news about Mars is that it may be, after all, warm enough there for life to exist. It has been claimed that because of the thinness of the Martian atmosphere the surface temperature of that globe must be very low, approaching the intense cold of space. This seems to be a mistake. Dr. W. W. Coblentz of the United States Bureau of Standards has succeeded in measuring the heat reflected from the Martian surface and comes to the conclusion that the mean surface temperature of our sister planet is between 50 and 70 degrees Fahrenheit, about the same as the mean temperature of the earth. The nights, however, are quite cold and the days very warm. This confirms Professor Percival Lowell's idea that the Martian climate is much the same as that of a terrestrial desert.

* * *

Radio Displaces the St. Bernard Dogs

THE Swiss Alpine Club proposes to install at several points on the Alps small radio stations by which lost travelers can summon help from towns far below in the valleys. So the rescue work begun many years ago by the monks of the Monastery of St. Bernard, assisted by their famous trained dogs, yields as does everything else in the modern world to the progress of science.

* * *

A Bishop Finds Old Friends by Radio

THE Bishop of Birmingham, in England, broadcast a talk recently and was surprised to receive many letters from old friends of whom he had altogether lost track and who communicated with him after hearing his voice again through the ether. Radio provides, the Bishop says, a new and unexampled way to extend one's personal touch to thousands of people whom one cannot hope to meet face to face.

* * *

Airplane Travelers Entertained by Radio

A NUMBER of the commercial airplanes used in passenger travel in Europe have been equipped with radio sets by which broadcast concerts may be received during flight. If the greenish tinge of countenance so frequently observable in the inexperienced air passenger as he alights at Paris or at London means anything, entertainment en route must be, we think, the least of one's desires. Yet it is possible that absorption in the remarks of one of the "uncles" of the British Broadcasting Company might be a welcome distraction, removing those disquieting thoughts of how little there is beneath the floor of the cabin.

Keystone

A FAITH-HEALER BY RADIO

Willis Vernon Cole, formerly a healer of the Christian Science Church, has recently issued a code book that covers every human ailment that the author feels capable of treating "metaphysically." Just send him the code word that covers your case—and the healer will do the rest by wire or radio.

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The Most Powerful Radio Equipment of Europe

WHILE the United States has been carrying on an intensive campaign in broadcasting and the use of radio by amateurs, France has been hard at work developing its commercial radio business through private enterprise. Today France is reported to have the largest, most efficient and most powerful equipment in Europe.

* * *

Radio Calls Bridal Couple to Sick Bed

A BROADCAST appeal by radio for knowledge of the whereabouts of Mr. and Mrs. George A. Lange, who were known to be on a honeymoon tour of New England, recently resulted in locating the couple in a secluded inn at the town of Lost River, N. H., whence they made their way home at once on receipt of a message that the bridegroom's mother was dangerously ill.

A Gold-Mounted Receiving Set for a Prince

AMONG the countless wedding presents received by the Duke and Duchess of York was a wonderful gold mounted radio receiving set. It is a portable loop receiver, mounted on a mahogany tea wagon, complete in every detail, with loudspeaker and even a charger for the storage battery attached to the shelf beneath.

* * *

Transmitting Sets for Japanese Fishermen

A NEWSPAPER dispatch reports that the chief of the Nagasaki Perfectural Marine Products Bureau of Japan, together with a committee of men interested in marine products, is reported to be investigating the possibilities of installing radiophone outfits on the larger sized fishing boats which have their base at Nagasaki, to enable them to communicate with shore when in difficulties, and to report the catch in time for their owners to realize on it.

General Electric

THE NEW "MAGNETO-MICROPHONE"

A new device, consisting of a moving magnetic coil pivoted between the poles of a permanent magnet which may be firmly anchored to the frame of a piano, has been developed by the engineers at the broadcasting station WGY. The instrument picks up the vibrations directly from the sound-board without any reference to the sound wave in the air. It is this principle that enables it to reproduce electrically all the fine shadings of tone-quality of the concert piano, and to eliminate the hissing and "tinny" sounds that almost always accompany transmission through a carbon microphone. In the picture is shown a studio piano that is equipped with three of these new microphones attached in positions that allow them to pick up the bass, the middle, and the treble ranges with the correct relative volume.

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Ask any radio expert

THE first duty of a radio panel is to give satisfactory insulation, as any radio expert will tell you. The wise fan selects his panel with special care and insists on having one that supplies the proper insulation resistance.

Celoron Radio Panels provide satisfactory insulation under all conditions. They have high dielectric strength and great surface and volume resistivity, and do not warp or crack when exposed to moisture.

Cut in standard sizes

For your convenience, Celoron Radio Panels come ready cut in eight standard sizes. Your dealer will hand you the size you want, and you can begin to build your set at once.

Celoron panels are easy to saw, mill, and tap, and will engrave evenly without feathering. Each panel is wrapped separately in glassine paper.

Select from the following standard sizes the panel that suits your needs:

1—6 x 7 x 1/8	5— 7 x 18 x 3/16
2—7 x 9 x 1/8	6— 7 x 21 x 3/16
3—7 x 12 x 1/8	7— 7 x 24 x 3/16
4—7 x 14 x 3/16	8—12 x 18 x 3/16

If your dealer cannot supply you, ask him to order, or write direct to us. Indicate by number the size you need. We also furnish Celoron in full-sized sheets and in tubes, and can cut panels in special sizes if desired.

This booklet free

Write for a copy of our booklet, "Tuning in on a New World," which contains a list of the leading broadcasting stations in the United States and Canada, an explanation of symbols used in radio diagrams, and several efficient radio hook-ups. It will be sent to you free on request.

To radio dealers: Send for special dealer price list showing standard assortments

Diamond State Fibre Company

BRIDGEPORT **(near Philadelphia)** **PENNSYLVANIA**

BRANCH FACTORIES AND WAREHOUSES
BOSTON CHICAGO SAN FRANCISCO

Offices in Principal Cities

In Canada: Diamond State Fibre Company of Canada, Limited, 245 Carlaw Ave., Toronto

CONDENSITE
CELORON
STANDARD RADIO PANEL

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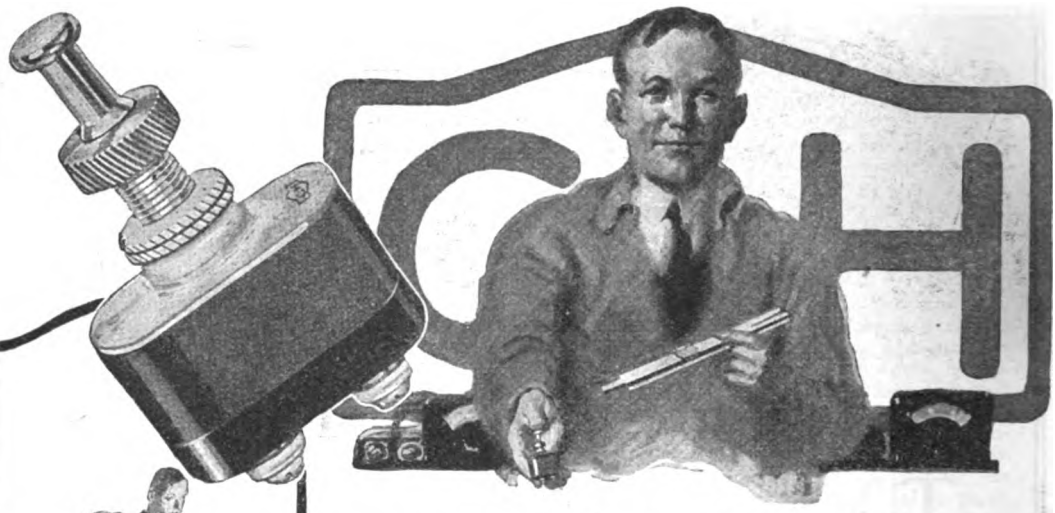

Disconnecting a battery lead is one way of shutting off a radio set, but many tubes and batteries have been ruined by putting it back on the wrong post. A C-H Radio Switch costs **75c**—*if you save only a few dry cells it quickly earns its cost.*

What do you do when the phone rings? Just push the C-H Radio Switch button—answer the phone—pull the button and the same program is back on. No turning back rheostats or disturbing your delicate settings when you have C-H convenience.

With the new tubes that operate at a dull red it is easy to forget to turn off the "A" battery—there is nothing to indicate whether the set is ON or OFF. The nickel button of a C-H Radio Switch sticks right out to say "I'm ON—don't forget me!"

A Switch by the Master Builder for Your Radio Panel

Beautiful Appearance
Correctly Designed—Easily Installed

In the radio world the name Cutler-Hammer and its symbol the famous C-H trade-mark have become guide posts to quality. In only a few months after their introduction more than a half million radio rheostats with the little mark of approval of the master builders of all electrical control apparatus were purchased.

Now these specialists offer another necessity for your panel, the C-H Radio Switch embodying the same careful design and workmanship to provide more pleasant, convenient reception and protect your expensive equipment at a negligible cost. Its sturdy knife blade mechanism that snaps—not merely slides—is capable of carrying 3 amperes at 110 volts, yet is built with a precision that enables you to use it in your most delicate circuits without any microphonic noises.

It will control your "A" battery to positively indicate whether the tubes are *on* or *off*—your "B" batteries—parts of circuits—condensers—battery charger—practically any demand you may have for current control. It is fully adjustable for panel thickness and can be installed in any set in a few minutes—only a single 7/16" hole is required. Carried by dealers everywhere—if yours has not yet been stocked, send 60c plus 10c carrying charges and you will be supplied direct.

THE CUTLER-HAMMER MFG. CO.
Member Radio Section, Associated Manufacturers of Electrical Supplies
MILWAUKEE · WISCONSIN

C-H

RADIO SWITCH

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Every Tube You Buy Should Have the Protection of C-H Control

There Is a Specialized Rheostat by the Master Builder for Every Requirement

The Cutler-Hammer engineers, world-famed specialists in electrical control, provided in their now famous C-H Radio Rheostats a new standard in accuracy of design and quality of workmanship among radio instruments.

Outstanding, was their originality of construction. Built almost entirely of non-warping metal—finished in beautiful satin nickel and ebony black—furnished with adjustable, spring contact fingers, comfortable knobs of genuine Thermoplax, and nickeled pointer, these rheostats were quickly recognized as worthy of the trade-mark they carried.

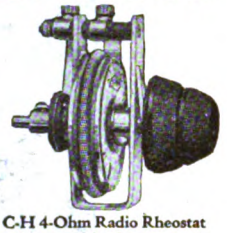
And as the science progressed and new tubes were introduced the C-H engineers evolved new models anticipating every requirement. Today there are four specialized C-H Rheostats (the 4-ohm vernier, the 4-ohm plain, the 30-ohm and the 125-ohm) to control any tube you desire. Each has been designed for the service it must render, and can only be wired to give the voltage needed for the tube it protects. For satisfaction in radio, demand the mark of the master builder on your control instruments.

THE CUTLER-HAMMER MFG. CO.
Member Radio Section, Associated Manufacturers of Electrical Supplies
MILWAUKEE, WISCONSIN

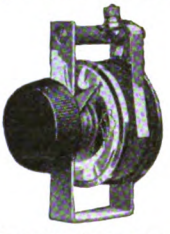
One Half Million* C-H *Radio Rheostats Now in Use

C-H

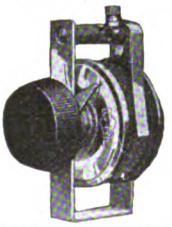
"Built by Rheostat Builders"



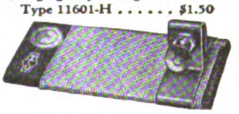
C-H 4-Ohm Radio Rheostat
Perfect control for the one ampere, six-volt tubes, or WD 11 (dry cell) type. With vernier, for detector tube control.
Type 11601-H1 . . . . . $1.50
Plain type for amplifier tube control.
Type 11601-H2 . . . . . $1.00



C-H 30-Ohm Radio Rheostat
Precise control of the one-quarter ampere, six-volt (UV 201-A and C 301-A) tubes or the UV 199 type on 4.5-volt source.
Type 11601-H9 . . . . . $1.50



C-H 125-Ohm Radio Rheostat
For control of the current-saving UV 199 tubes on a current source of six volts. Use your storage cell with the new tubes—it will need recharging only at long intervals.
Type 11601-H $1.50



C-H Variable Resistance Unit
Adds to your five-ohm rheostat just the resistance required to control the ¼ amp. 6-volt "A" type tubes or the UV 199 type. Saves the cost of new rheostats and the trouble of redrilling your panel. Fully adjustable for change in battery potential.
Type 11601-H12 . 25c

CUTLER-HAMMER

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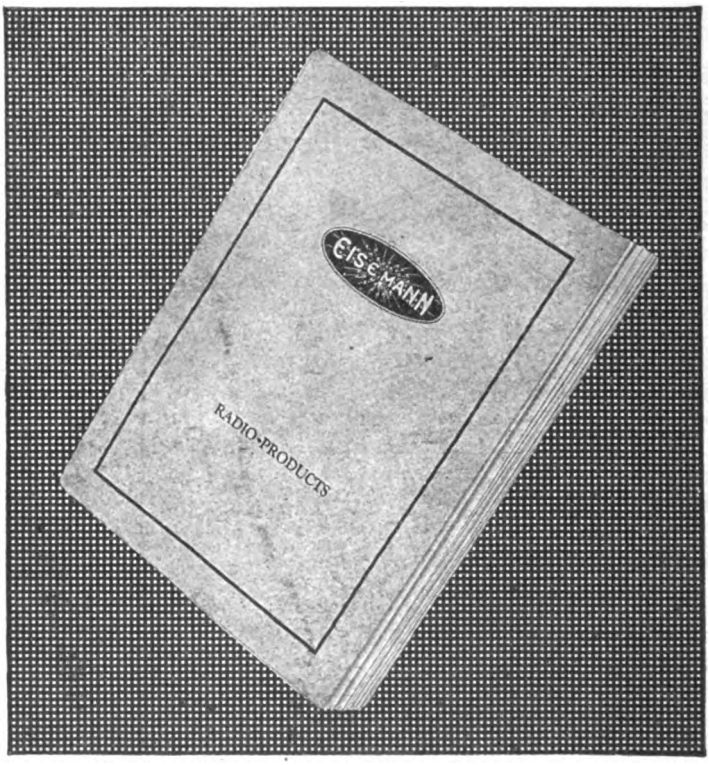

Just off the Press

Upon request, our latest radio catalogue will be sent to those interested in the construction of receiving sets—without charge.

Each part we manufacture is illustrated and described in detail.

Write for it today.

EISEMANN MAGNETO CORPORATION

William N. Shaw, *President*

BROOKLYN, N. Y.

DETROIT CHICAGO SAN FRANCISCO

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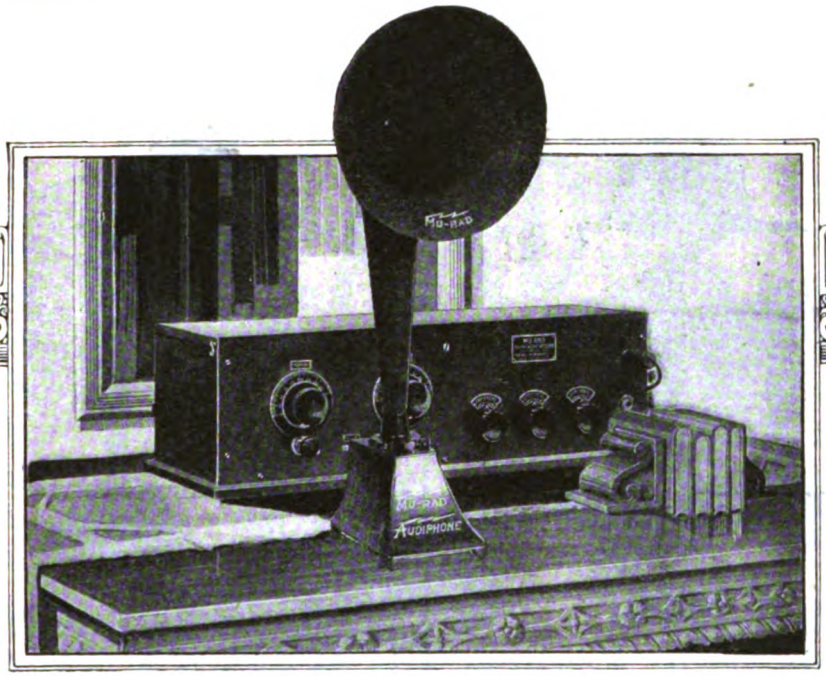

A New MU-RAD *Accomplishment* — *The* MU-RAD AUDIPHONE

The super-sensitive mica diaphragm produces sound by the contraction and expansion of an actuating contact, just as the vocal cords produce the voice.

No Extra Battery Connections

PRICE
$25

THE REVOLUTION, wrought in radio reception by the MU-RAD RECEIVER is equalled by this radical improvement of sound amplification. The *MU-RAD AUDIPHONE* aimed for a higher perfection than ever attempted — duplication in electro-mechanical form of the greatest sound producing organ, the human voice. The result of five years' continuous research is a radio reproducer worthy of a finer classification than "loud speaker"; it is *a new radio instrument!*

WRITE FOR LITERATURE AND THE NAME OF THE NEAREST MU-RAD DEALER DEMONSTRATING THE MU-RAD AUDIPHONE

MU-RAD LABORATORIES, INC.

809 FIFTH AVE. ASBURY PARK, NEW JERSEY

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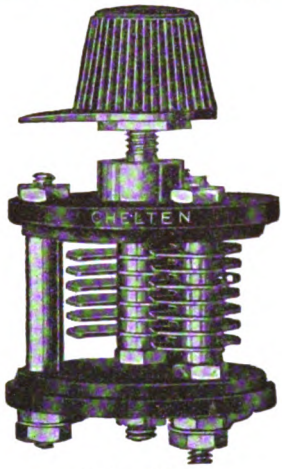
CHELTEN RADIO SPECIALTIES



Price **$1.50**

Actual Size
Patents Pending

Accurate Vernier Regulation With The Chelten Midget
(A VARIABLE CONDENSER)

The CHELTON MIDGET furnishes the most accurate Vernier regulation when **shunted** across the plate of the main condenser with minimum body capacity.

By far the easiest and most accurately adjustable **neutralizing condenser** on the market, having a capacity range of .00001 to .000045 MFD, such as required for **Hazeltine's Neutrodyne** and other circuits.

The Chelten Midget Condenser adjustment can be used to replace all fixed condensers regardless of capacity and give a vernier adjustment if required.

The new Chelten Catalogue showing a number of new instruments will be ready for mailing to all recognized jobbers and dealers October 1st. Write for your copy.

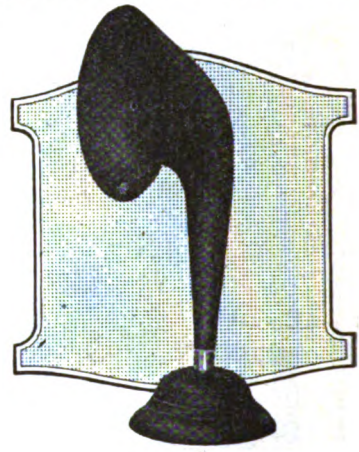
Pocket Hand Edition will be ready for mailing to amateur radio fans November 1st.

Since 1910 Manufacturers of High Grade Electrical Specialties

Chelten Electric Company
4863 Stenton Avenue **PHILADELPHIA**

CHELTEN RADIO SPECIALTIES

YOUR PHONE PLUS A FIBERTONE MAKES A BEAUTIFUL MUSICAL INSTRUMENT



Tribune Institute Approves "Fibertone"

The New York Tribune Institute has approved the "Fibertone"—a tribute only to quality merchandise of proven performance.

And performance is what counts! Here the Tribune makes this complimentary statement: "Excellent reproductions are obtained with a Fibertone in use with a single phone from any good head set."

Make your own comparison and it will be found that for the price, the Fibertone is unequalled in tonal quality. Its construction is entirely of fiber, insuring against tinny and vibrative blasts. Operates on one stage of amplification. Your dealer will gladly help make this comparison for you.

#2 Fibertone (14 in.).....$12.50

FIBER PRODUCTS CO.
240-C North 10th St. **Newark, N. J.**

$8

FIBERTONE
RADIO **HORN**

Jobbers and dealers write for trade prices

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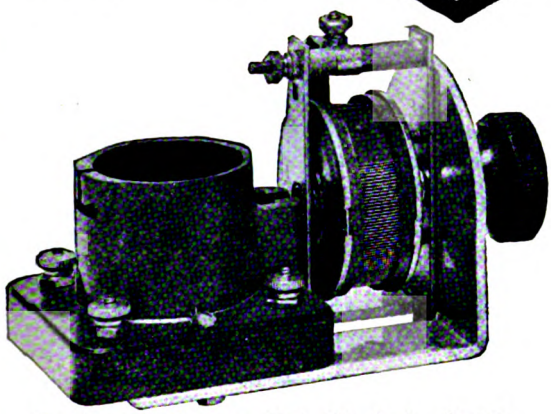
MAKES

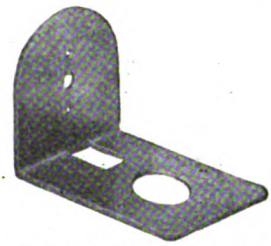
SE-AR-DE

YOUR

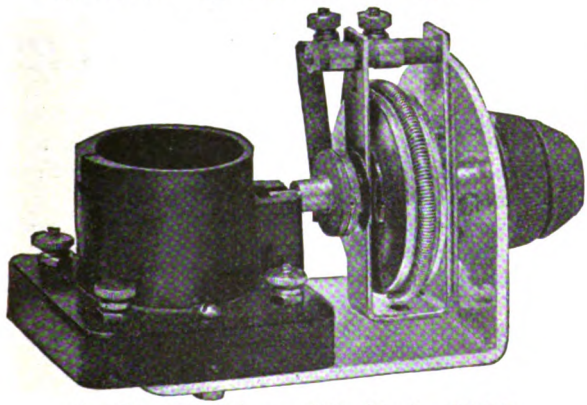
MOUNTING EASY



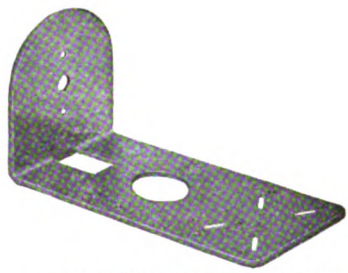
Cat. No. 206 Detector Unit (30 ohm)—$3.00
Cat. No. 211 Detector Unit (4 ohm)—$2.40
Cat. No. 198 Amp. Unit (4 ohm)—$7.50
Cat. No. 105 Amp. Unit (30 ohm)—$8.10



MOUNT YOUR OWN
DETECTOR BRACKET
Cat. No. 217—30c



Cat. No. 139 Detector Unit (Ver.)—$3.00



MOUNT YOUR OWN
AMPLIFIER BRACKET
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R. MITCHELL CO.

255 Atlantic Ave. **Boston, Mass.**

Pacific Coast Office: 709 Mission St., San Francisco
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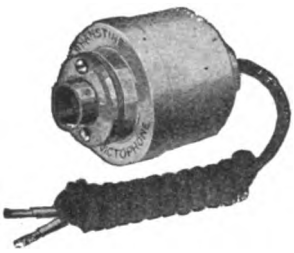
RHAMSTINE*

Victophone

Loud Speaker



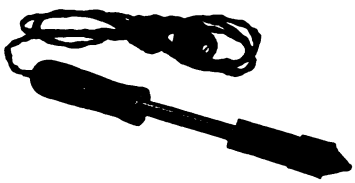
Replacing the tone-arm of your phonograph, the **Victophone** gives you undistorted amplification and a full, pleasant tone and volume that is incomparable. If your dealer hasn't the **Victophone**, we'll gladly send it, post paid. State make of phonograph.

$7.50
Complete with Cord

For home or laboratory.
The Rhamstine*

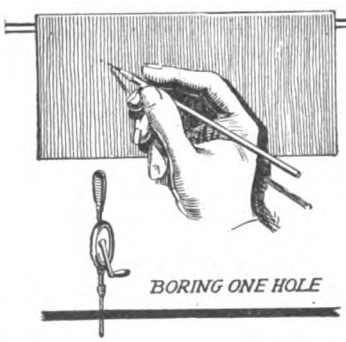
Electric Soldering Iron is especially designed to meet the needs of the radio experimenter. Nichrome element, renewable tip, nickel finish. Complete with plug, cord and self-fluxing solder.

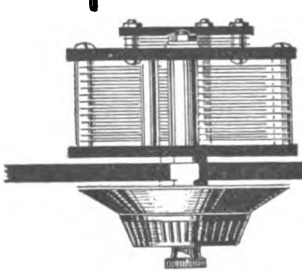
$2.50
Complete



J. THOS. RHAMSTINE,* Woodbridge at Beaubien Detroit, Mich.

** Maker of Radio and Electrical Products*





RATHBUN

SINGLE-HOLE MOUNTING

SUPERIOR CONDENSERS

ANOTHER point of RATHBUN extraordinary superiority —stator plates—all one rigid, immovable unit. Spaced to the thousandth of an inch and then anchored solidly into precision-milled brass tubes by die-casting under extreme pressure. No possibility of warping, no adjusting, no washers. This point, with single hole mounting and other points of RATHBUN superiority, makes these condensers distinctly better value.

LIST PRICES—RATHBUN CONDENSERS

PLAIN TYPE			
5 Plate	.000125	$3.00
11 "	.00025	3.00
23 "	.0005	3.50
43 "	.001	4.50

VERNIER TYPE			
3 Plate	.000075	$1.00

COMBINATION VERNIER TYPE			
3-11 Vernier Variable		$4.50
3-23	"	"	5.00
3-43	"	"	6.00

Write TODAY for the name of the nearest Rathbun dealer and for illustrated literature.

RATHBUN MANUFACTURING CO.
Jamestown, New York

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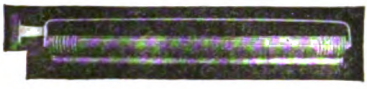
REG. U.S. PAT. OFF.

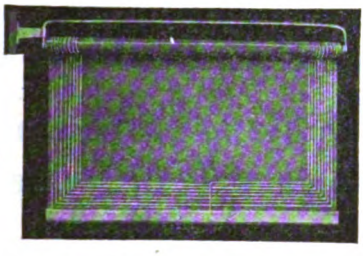
A New Pathé Product

CURTANTENNA

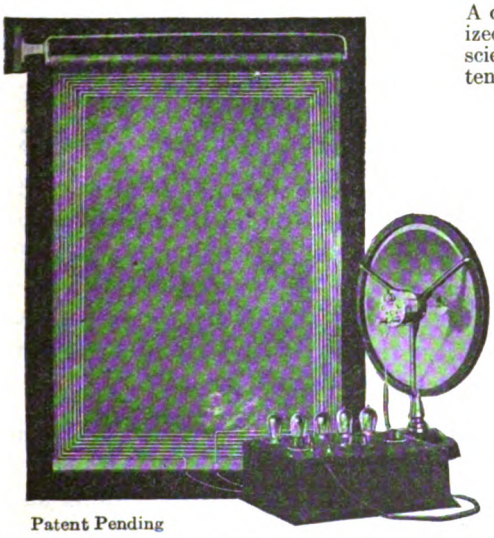
The Only Variable Loop



Showing Collapsibility and Portability of Curtantenna



Showing How Curtantenna Can Be Varied In Size



Patent Pending

Showing Curtantenna Fully Extended in Conjunction with Set and Pathé Loud Speaker

A REVOLUTIONARY development in radio aerials for indoor use.

When fully opened is one of the largest and most efficient loops for broadcast reception.

Is instantly collapsible without kinking or tangling the wire.

Ideal for sharp tuning—unsurpassed for distance—reduces static to a minimum. Particularly effective in large cities where several stations are broadcasting at same time. Gives a degree of selectivity hitherto unobtainable.

When closed is as portable as a walking stick.

Comes with wall bracket and swivel or may be attached to any door in house.

Positive in results—very attractive in appearance—easy to handle.

Size can be varied at will.

Over 1500 miles have been covered by users of the CURTANTENNA.

A quarter of a century of highly specialized experience in the manufacture of scientific devices is behind the Curtantenna.

Price $8.50

On sale at leading radio stores. If your dealer has neglected to stock the Curtantenna, send remittance direct and shipment will be made, charges prepaid, immediately.

Other Pathé products such as the famous Pathé Loud Speaker, Pathé Dials and Pathé Variometers and Variocouplers have already established themselves as standards among users of the best radio material.

Catalogue of Pathé radio products, together with a detailed wiring diagram of a loop receiving set which covered 1500 miles using a CURTANTENNA, will be mailed on receipt of 4 cents postage. Address Dept. 198

PATHÉ PHONOGRAPH & RADIO CORPORATION
20 GRAND AVE., BROOKLYN, N. Y.
533 SO. WABASH AVE., CHICAGO, ILL.

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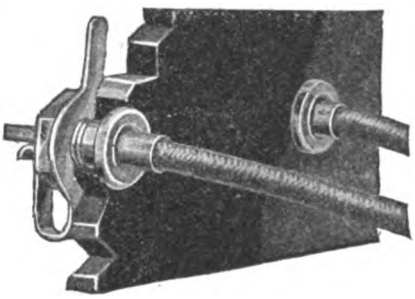
Quick, Positive Connections

UNION RADIO

TIP JACKS



Cost Only 25c a Pair

That they give you quick, positive temporary connections is only one of the many big advantages of Union Radio Tip Jacks. Just what you want when you build your own set or experiment with different circuits and hook-ups.

They can be attached to all standard thicknesses of panels. The bushing is ¼" in diameter and fits a ¼" hole. Will grip all wires from 24 B & S gauge up to antenna wire, battery leads, loading coils and vacuum tube lugs.

No parts to chip, lose and deteriorate. All parts heavily nickeled.

Other Guaranteed Parts

Dial adjusters for minute variations in capacities of variable condensers. Price 60c.

Variable Condensers. Famous for performance Without dials, 3 Plate—$1.00; 13 Plate—$2.00; 23 Plate—$2.30.

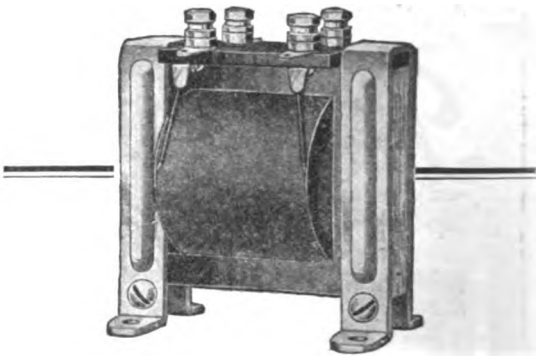
Tube sockets of molded condensite highly polished. Phosphor Bronze contact springs. Reinforced bayonet slot prevents breakage. Accommodates all standard tubes. Price 75c.

Should your favorite Radio Store not carry Union Radio Tip Jacks and Guaranteed Parts send your order direct to us, also write for your copy of "The Union Radio Catalog A."

Retailers and Wholesalers

Samples of our guaranteed, reasonably priced "Quality Products" sent on request. Our terms and trade discounts are liberal. Write for our proposition.

UNION RADIO CORPORATION
200 MT PLEASANT AVENUE, NEWARK N.J.
NEW YORK OFFICE — 116 WEST 32ND STREET.



GENUINE

JEFFERSONS

The Standard Audio Frequency Transformers

No matter what circuit you wish to complete, there is a JEFFERSON Audio Frequency Amplifier which will insure 100% Amplification, the elimination of distortion and the quiet easy tuning so eagerly sought after.

FIVE JEFFERSON TYPES

to choose from—manufactured by the pioneers in the audio frequency transformer field. Right from the start put Jeffersons in your set—don't experiment—expert Radio Engineers, after careful and exhaustive tests have found them perfect in every detail of construction.

DESCRIPTIVE BULLETIN sent free and our Engineering Department will be glad to make recommendations as to the proper transformer to be used in any circuit.

Jefferson Electric Mfg. Co.

427 S. Green Street **Chicago**

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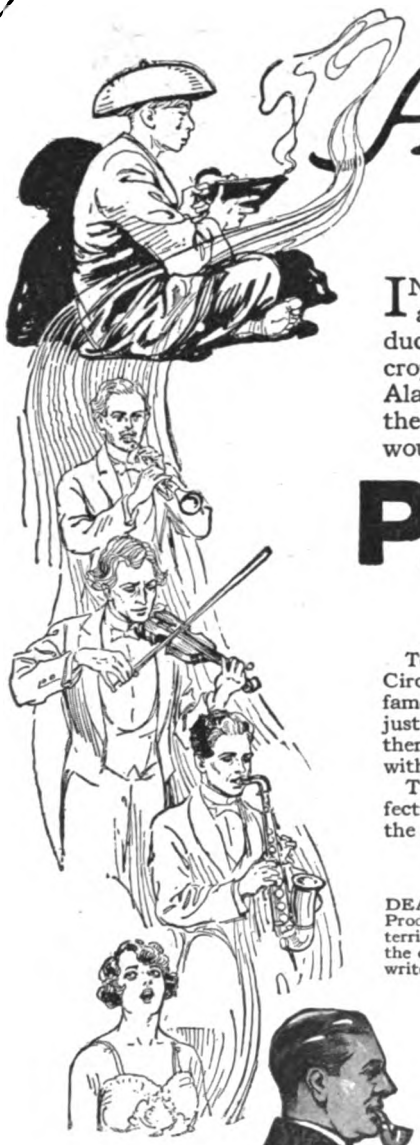

Aladdin's Lamp Outdone

IN the fairy stories they asked Aladdin for music and by rubbing his wonderful lamp he produced it for them. No doubt if they had wanted crop and market reports or a bedtime story Aladdin could have produced them also. But these were fairy stories. Whoever thought they would come true?

PARAGON

Reg. U.S. Pat. Off.

RADIO PRODUCTS

Tonight if you sat down with a PARAGON Three-Circuit Receiver you could hear the music of a world-famous orchestra or the marvelous voices of opera singers just as clearly as if you were sitting in the same room with them. You can choose the program you want and enjoy it without interruption.

The name "PARAGON" on radio products means perfection. To listen in with a Paragon set is to experience the full fascination of the world's latest wonder.

An Illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS: We believe in the proper distribution of Paragon Radio Products. Our exclusive Distributors are particularly interested in territorially protected dealers, who will concentrate, solicit and serve the consumer in the sale of Paragon Radio Receivers. If interested, write us for details.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

Illustration shows Type RD-5 Regenerative Receiver and Detector —$60.00

Type A-2 Two-Stage Amplifier—$40.00
(Licensed under Armstrong Patents)

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"ALL-AMERICAN"

Sets another World Record!!

THE RECEPTION on board the Berengaria, night after night, of the signals from the Drake Hotel, Chicago, during the entire voyage, from New York to Cherbourg, France, a distance of 4000 miles, was a world record achievement for consistent reception. The set used employed "ALL-AMERICAN" Amplifying Transformers.

Today another record is being made. Slowly winding its way up into the frozen North is the Bowdoin, on board of which is Captain Donald B. McMillan, on a scientific expedition to the North Pole.

Night after night, up in the Artic Ocean, he is listening to the world thousands of miles south of him. Again "ALL-AMERICAN" Amplifying Transformers are being used, and again new world records are being achieved.

You, too, can set new records with your own set by the use of "ALL-AMERICAN" Amplifying Transformers.

Ask your dealer to show you these world record-breaking instruments. They are as attractive as they are efficient.

Book of Successful Hookups sent free on receipt of 2c for postage.

Audio Frequency Transformer

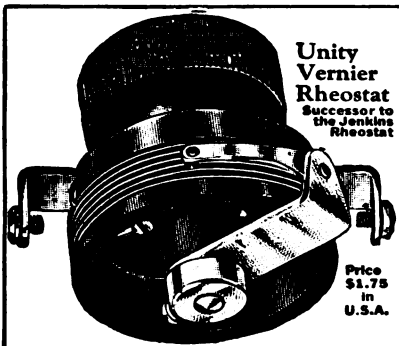
Radio Frequency Transformer

ALL-AMERICAN

RAULAND MFG. CO.

200 No. Jefferson St., Chicago, Ill.

ALL-AMERICAN



Unity Vernier Rheostat

Successor to the Jenkins Rheostat

Price $1.75 in U.S.A.

Interchangeable Resistance Cartridge

Complete $.80
Bracket - .45
Cartridge .35

Unity Cartridge Rheostat

Unlimited Adjustment

and Practical Convenience

The highest type electrical instrument for controlling resistance. A single wire followed its entire length by a contact gives noiseless adjustment and permits infinitesimal refinement in tuning. A cut-out switch turns tube on or off with absolutely no change in tuning. Made in any resistance. Stocked in 8 ohms, 20 ohms and 40 ohms. All capacities $1.75 list.

Built for Convenience

Nothing like this new Unity Cartridge Rheostat has ever been offered the radio enthusiast. Interchangeable resistance cartridge may be slipped in or out by hand in a moment's time without removing bracket or terminal. No need to buy new rheostats when you change tubes in your set. Simply pay 35c for the Unity Cartridge of the correct resistance. Made in any resistance. Stocked in 8 ohms, 20 ohms and 40 ohms. All cartridges 35c list. If your dealer cannot supply you, send money order or check and dealer's name to factory.

"Hear a set that uses one"

Unity Manufacturing Company

226 North Halstead Street, Chicago, Ill.

Automatic Screw Machine Products, Stampings—
General Manufacturing on Contract or Royalty

DEALERS: Send name and address to Factory for Free Counter Display

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The Uncanny Amplion
A "Human" Loudspeaker

YOU can scarce believe your ears when you first hear the Amplion Loudspeaker.

The clearness, softness and rich tone-quality with which it reproduces voice and music are so real as to be uncanny. You get a new thrill from radio. Delicious "chills" course up-and-down your spine, as they do when you listen to some master of voice or instrument face-to-face.

American Engineers who have tested the Amplion are unanimous in their opinion that for true reproduction and volume it's the best loud speaker yet produced.

The Amplion is not a head receiver fitted with a horn, but the adaption for Radio of an electro-magnetic and acoustic instrument which for thirty years has been successfully used in all parts of the world.

Ask your dealer to let you hear the wonderful "AMPLION" Loudspeaker. Send for illustrated folder.

Patentees Alfred Graham & Co.

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The Supremacy of the AMPLION
is the Supremacy
of Actual Performance

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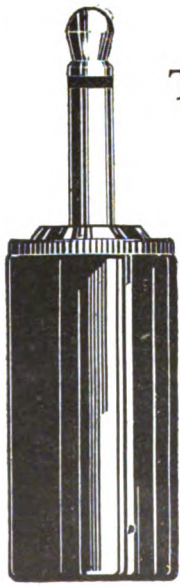
Good Plugs Are Important

The successful operation of any radio receiving set depends upon the accurate functioning of *every* part in the set. Plugs on headpiece and loud speaker cords are important units.

Without good plugs you can't get good results.

CICO



TWO WAY RADIO PLUGS

are the largest selling round plugs in America today because no other plug made combines such sterling qualities with so low a price.

Price 60c

Consolidated Instrument Company of America, Inc.

41 East 42nd Street

New York

Teleradio

Radio Engineers Know— *and buy these features*

SUPER-SENSITIVE

1. **A guarantee that less than five per cent variation in resistance ever exists between the coils of Teleradio head sets. The secret of accurate reproduction of faintest signals.**

2. **Positive adjustment of diaphragm—insures best tonal qualities.**

3. **Improved self adjustable friction-sleeve—positive position grip.**

4. **Drawn aluminum case—all metal parts highly nickel polished. Light and durable for the hardest usage.**

5. **Fabricated head band for unusual comfort and ease.**

6. **Latest engineering principles and best of materials employed in every detail of construction and manufacture.**

If your dealer cannot supply you, write for catalogue and prices.

$5.50

VERNIER CONDENSERS
23 plate $4.50 43 plate $5.50
VARIABLE CONDENSERS
3 plate $2.00
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23 plate $3.00
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(6 and 30 ohm) $1.00
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(2,000 ohm) $5.50
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TELERADIO ENGINEERING CORP.

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Natural Re-PRODUCTION

Atlas AMPLITONE

LOUD SPEAKER

$25

ALL of the program, natural as the original, re-PRODUCED on the *Atlas Amplitone*. Faithfully responsive, not to just one small range of sound intensity, but to the *full scale* of tone harmonics. The "double diaphragm" —triumph of the radio and acoustic sciences — automatically accommodates itself to every pitch. Blast and distortion are entirely eliminated. The "double diaphragm" is adjustable to operate most efficiently with individual receiving conditions. Ask the nearest Atlas Amplitone dealer for a demonstration. Hear the difference this great innovation makes.

Letters from Users Requested

What have you accomplished with your Atlas Amplitone? Tell us about it!

Write for Booklet "B"

Contains helpful information.

Sole Canadian Distributors

The Marconi Wireless Telegraph Company of Canada, Limited

Montreal Canada

Multiple Electric Products Co. Inc.

ORANGE ST. RADIO DIVISION NEWARK, N. J.

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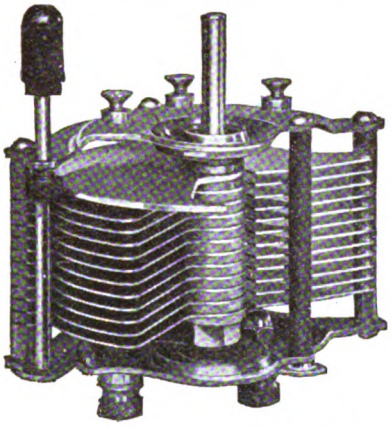
MIGNON NEW TYPE

STRAIGHT LINE VERNIER

AIR CONDENSERS



POINTS OF SUPERIORITY

1. Stator plates instead of being loosely fitted are pressed into slots assuring *perfect electrical contact.*
2. Proper capacities and no over-rating of same.
3. Rigid construction so original adjustment is maintained.
4. Rotor and Stator plates of logarithmic curve type.
5. Formica insulation throughout.
6. Patented vernier arrangement eliminating body capacity.
7. Accurate and correct spacing of special spring aluminum plates.
8. Lowest dielectric losses proven by laboratory tests.
9. Friction adjustment on rotor shaft, assuring positive and permanent tuning adjustment.
10. Independent vernier control. Vernier does not rotate with main rotor plates.

COMPARE PRICES AND QUALITY

Type G., 13 Pl., .0002 M. F., $2.75—Type H., 23 Pl., .0005 M. F., $3.25—Type J., 43 Pl., .001 M. F., $3.50.

These Prices Subject to Advance Nov. 1, 1923

Sold by all Leading Electrical Firms and Radio Dealers.
If not Obtainable from Your Dealer, Write us Direct.

Jobbers, Dealers and Set Manufacturers Write for Discounts.

MIGNON ELECTRIC MFG. CORP.

27-33 SOUTH WATER STREET ROCHESTER, N. Y.

MOON LOUD SPEAKER

the Most Successful Non-Magnetic Instrument

only $7.50

There is no rasping, no growling, no harshness. It reproduces exactly what your set brings in—with larger volume—clear, mellow, resonant tones that all can hear.

The New 1924 Models

are now ready. Even better than the 1923 Speaker that brought delight to thousands of radio homes. Two types, for single or double phone connections, same price. For use with your own phones. Heavy iron sound channels. Horn of heavy aluminum, with beautiful black indestructible finish. Fifteen inches high.

Hear the Moon Loud Speaker at your dealer's. If he hasn't got it, order direct from us on our guarantee of satisfaction or refund.

Dealers: Write for proposition.

WILSON UTENSIL CO.

DEPT. W. DAYTON, OHIO

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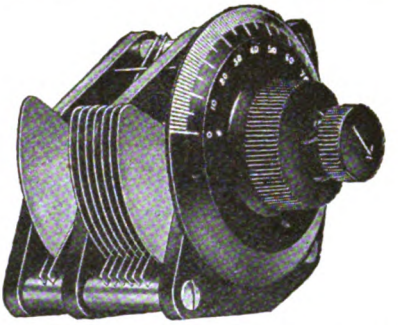
CHELSEA

LEADERSHIP THRU QUALITY AND COMPLETE LINE

THE IMPORTANCE OF
VARIABLE CONDENSERS



NEARLY all modern receiving circuits contain one or more variable condensers. Upon the performance of these vital parts depends largely the degree of success of your receiving set. It is easy to produce condensers which look efficient, but effectiveness in these parts is much more than skin deep.

CHELSEA VARIABLE CONDENSERS

Enable any receiving circuit to give its best. Plates are die cast into solid units giving permanence of electrical and mechanical connections and rigidity at all times. This is the only sure method of construction which avoids corrosion and insures low resistance. Insulating material is the best obtainable—genuine bakelite—molded by Chelsea. This insures low electrical losses. Large brass self-aligning bearings eliminate all play and maintain the proper air gap at all times. Plates are of heavy stock of the proper design. These are some of the reasons why you should use Chelsea condensers to achieve the results you hope for.

Made in eleven styles, they form a complete line in which there is the proper type and capacity for any receiving circuit.

Prices from $2.50 to $6.75

OTHER QUALITY CHELSEA PARTS:

Variometers with Vernier	$8.00	Rheostats	$1.00 and $1.40
Varicouplers	8.00	Tube Sockets	.50 and .75
Audio Transformers . . .	$3.75 and 4.50	Dials	.40, .45, and .50

Write to Department 3 for our large catalog, which illustrates and describes the complete line of Chelsea Receiving Sets and Parts

NATIONAL CHELSEA RADIO CORP.
739 Boylston St., Boston, Mass.

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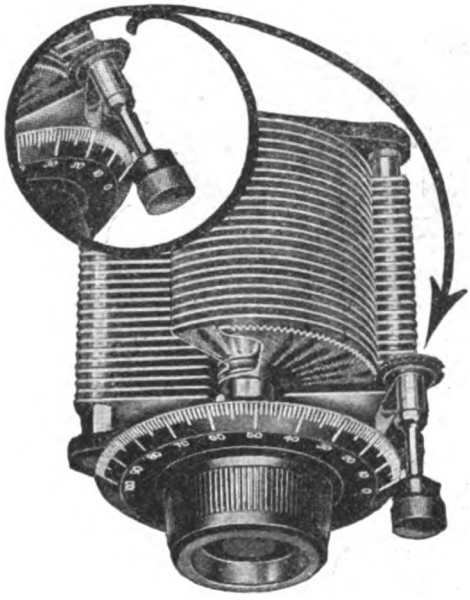


Heath's Radiant Condensers

Now the "guess" has been taken out of condenser buying. The source of greatest uncertainty, the plates, by a new process of stamping and temp ring in **Heath's Radiant Condensers** are PERMANENTLY FLAT. They are as proof against warping and buckling as a steel straight edge. These condensers will keep their fine alignment without any adjusting during their **entire life!**

A Vernier Adjustment Geared Like a Watch

Ordinary vernier adjustment reduced to micrometer fineness. Extreme delicacy of adjustment. Smooth, positive, accurate as a watch. **Heath's Radiant Condensers** are especially adaptable to the fine tuning required on high amplification.

Write for Illustrated Folder.

PRICES

Vernier Type

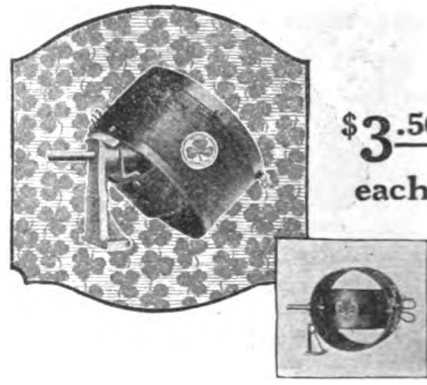
13 Plate including 2⅞" dial and knob..... **$5.00**
25 Plate including 2⅞" dial and knob..... **5.50**
45 Plate including 2⅞" dial and knob..... **6.50**

Jobbers and Dealers Write Immediately for Proposition

HEATH RADIO & Electric Mfg. Co.

204 First Street
Newark, N. J. U. S. A.

IMITATED BUT NEVER DUPLICATED



DEPENDABLE — *for all new wave lenghts*

—Range 150 to 600 meters, tunes in on all new high wave lengths.

—180° type, gives double selectivity of ordinary 90° instrument.

—Tubes of genuine grade XX bakelite wound with single green silk covered wire.

—Angular movement of rotor gives super selective tuning with ease.

—Direct flexible leads to Fahnestock clips eliminate contact noises of spring contacts.

—Aluminum die cast frame reduces body capacity. For bench or panel mounting.

VARIOMETER
Write for descriptive specifications

Dealers write for trade prices

SHAMROCK MANUFACTURING CO.
320 Market St., Newark, N. J.

SHAMROCK
FOR SELECTIVE TUNING

180° VARIO-COUPLER VARIOMETER

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MU-RAD ★ RECEIVERS

The Ultimate in Radio Reception

The New Star in the Radio World

"WHEN KNIGHTHOOD WAS IN FLOWER," Crusaders in distant lands communicated with their own countries by carrier pigeon. The system, learned from the Saracens, was greatly perfected by the Crusaders. *Today*, ordinary radio reception has been excelled by a new perfection of the art—MU-RAD RECEIVERS. Swift as thought, clear as the voice, sensitive beyond belief! Cities, 4300 miles and more away, send their news and entertainment to the MU-RAD owner. Conservatively guaranteed for 1000 miles, using only a two-foot loop aerial.

WRITE FOR LITERATURE

MU-RAD LABORATORIES, INC.

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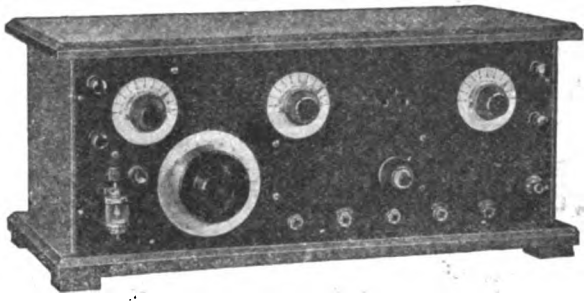
EACO DUPLEX RECEIVERS



Excel in—

RANGE
VOLUME
CLARITY
EFFICIENCY

A Revelation in Radio Frequency

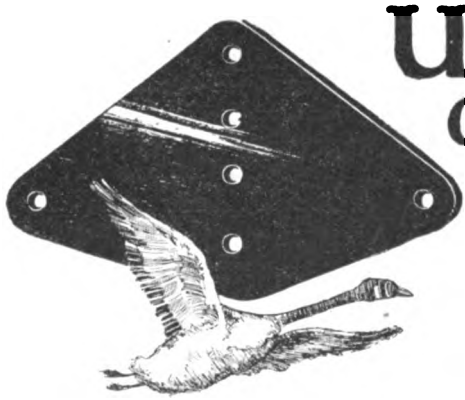
A supersensitive Receiver incorporating two stages of Tuned Radio Frequency. Affords the user choice of either crystal or tube detector, with or without amplification. Ideal for use with loud speakers of any type. Delivers great volume from distant Broadcasters. Will operate without an aerial.

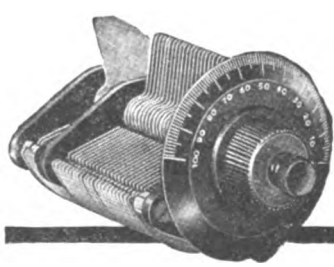
Literature and prices furnished upon request.

ECONOMIC APPLIANCE COMPANY, Irwin, Penna.

U.S. TOOL
CONDENSERS

WITH THE PERFECT END PLATES OF LAMINATED CONDENSITE CELORON





CHEAPER insulating materials *might* do as well, for ordinary purposes, but our respect for the good opinion of the radio public permitted nothing but the best—CONDENSITE-CELORON. Moisture, which only needs to be retained on the surface to form a perfect path for the escape of radio frequency currents, vanishes from the surface of CONDENSITE-CELORON "like water off a duck's back." Greatest dielectric and tensile strength.

U.S. TOOL COMPANY INC. *116 Mechanic St. Newark, N.J.*

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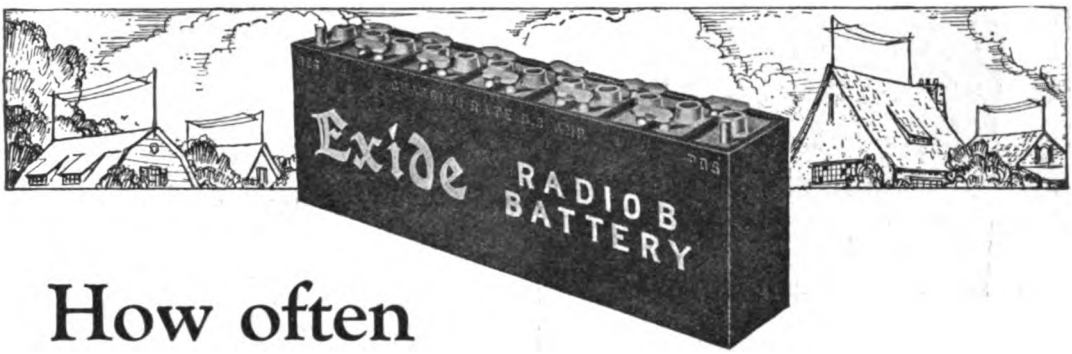


How often do you get a new B battery?

THE current from a B battery is relatively small. But it must be always on the job. B batteries that run down quickly are the bane of the radio fan's existence. Your B battery can help you get the most pleasure from radio, or it can be your greatest nuisance. It all depends on the kind of battery you buy.

The wise radio amateur knows it pays to get a good B battery in the first place. And that means an Exide. The new Exide B Battery is built with extra-heavy plates. That is one reason why it lasts so much longer than the ordinary battery. It can be recharged again and again, saving you the annoyance of frequent replacements.

Exide B Batteries give steady, noiseless current. They are strangers to the hissing, frying noises caused by internal discharge. The 12 cells are encased in rubber, with special vents to allow gas to escape when the battery is being recharged. They are designed throughout to prevent electrical leakage.

Exide A Battery for six-volt tubes

Supplies uniform filament current. Is dependable and long-lasting. Comes in four sizes, of 25, 50, 100 and 150 amp. hr. capacities.

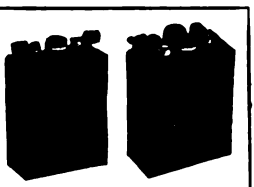
Two low-voltage A batteries

If your set operates on low-voltage tubes, it will be worth your while to examine the new Exide two- and four-volt A batteries. They are right in line with the latest developments in radio receiving. The one-cell Exide A Battery will heat the filament of a 1.1 volt .25 ampere tube for 96 hours; the two-cell Exide A Battery will heat the filament of a 3 volt 60 milliampere tube for approximately 200 hours. They are specially adapted to WD-11 and UV-199 vacuum tubes.

The Exide A Battery for six-volt tubes gives full-powered, care-free service. It requires only occasional recharging. Like all Exide Radio Batteries, it is built of the finest materials available, is sturdy and long-lasting.

When you hook up your set with Exide A and B Batteries, you are sure of getting maximum signal strength. You can reproduce broadcast selections in clear bell-like tones.

Wherever reliable storage batteries are required, you will find the Exide doing its work ungrudgingly. It is recognized as the leading storage battery in every field of industry. A majority of all government and commercial wireless plants are equipped with Exide Batteries.



Two- and four-volt A batteries

Consist of one and two cells, respectively, with rated capacities of 24 and 12 ampere hours. The two-volt battery weighs 5 lbs., the four-volt battery 6 lbs.

Don't let inefficient batteries spoil your pleasure in radio. Go to any radio dealer or Exide Service Station and ask for Exide Radio Batteries.

If your dealer can't supply you with free booklets describing the complete Exide line, write direct to us.

Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Oldest and largest manufacturers in the world of storage batteries for every purpose

Service Stations Everywhere **Branches in Seventeen Cities**

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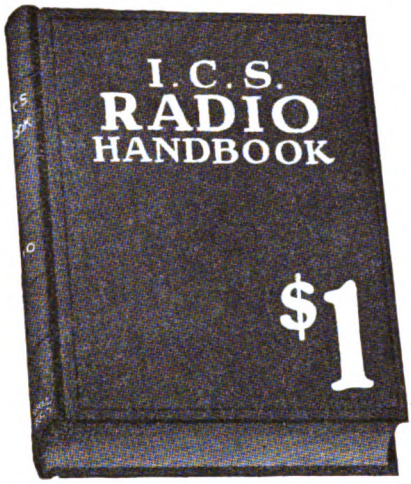

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RADIO

514 pages. Price only $1

Compiled by **HARRY F. DART, B.S.E.E.**
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Technically edited by **F. H. DOANE**

THE most complete book of its kind ever published. Written, compiled and edited by practical radio experts of national reputation. Packed with concise, sound information useful to every radio fan—from beginner to veteran hard-boiled owl. Hundreds of illustrations and diagrams to make every point clear. Note this *partial* list of contents:

Different types of receiving and sending hook-ups, electrical terms, condensers, oscillating circuits, coupled circuits, induction coils, antenna systems, electric batteries, generators and motors, protective devices, crystal detectors, arc generators, transmitters, filters, wavemeters, radio experiments, International and Morse codes, commercial receiving sets, tables and data, radio transmitting and broadcasting stations (with call letters), Radio License Regulations, etc.

Send $1 to-day and get this 514-page I.C.S. Radio Handbook before you spend another cent on parts. Money back if not satisfied.

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I enclose One Dollar. Please send me—postpaid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

Name.....

Address.....

Send 50c for this FADA NEUTRODYNE BOOK

It tells in simple language how to construct a Neutrodyne circuit receiver using FADA parts. Nothing is left in doubt. Both four and five tube Neutrodyne wiring diagrams are included. In addition, in the rear of the book there are both four and five tube full size paper panel drilling templates.

This 32-page book and the use of FADA Neutrodyne and standard parts will insure successful Neutrodyne circuit receiver construction.

F. A. D. ANDREA, INC.

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The special FADA Neutrodyne parts including three Neutroformers, two Neutrodons and the HOW-TO-BUILD-IT book sell for $25.00.

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MARKET reports through the AUDIOPHONE can be depended upon because nothing is lost from the original broadcasting.

Not only is it easily possible to distinguish the words of a speaker, but also the minute graduations in pitch, timber and quality of overtones, which distinguish individual voices.

The same qualities that make the AUDIOPHONE a source of profit by day, gives pleasure in the evening to the entire household, furnishing entertainment and education of a varied nature because it is equally efficient in reproducing the speaking voice, singing voice and all musical instruments.

The AUDIOPHONE is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use in connecting to your receiving set. It will prove a source of lasting pride and pleasure.

Audiophone Sr.	$32.50
Audiophone Jr.	22.50
Bristol One Stage Power Amplifier	25.00

Send your name and address to receive copy of Bulletin No. 3006-L.

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NOTHING IS WORTH WHILE UNLESS IT IS "RELIABLE"

75¢

A little device that makes a vast improvement in your radio receiving

RELIABLE NEUTRALIZING CONDENSER

for all tuned radio circuits and all latest type circuits

THIS little fellow is all that a cough drop means to a husky throat—it clears up your messages so as to take out the "scratchy" fog-horn effects that otherwise mar concert, lecture or song.

It has many other uses. For tuning to the higher wave length broadcasting stations, it greatly increases the tuning range; also neutralizes the capacity reactance of inductive couplings, affords a vernier adjustment for the grid condenser, and is particularly favored for balancing up all circuits to give a fine adjustment.

AUDIO AND RADIO FREQUENCY AMPLIFYING TRANSFORMERS

Audio transformers furnished in three different stages of ratios as follows:

6 to 1 4 to 1 2 to 1

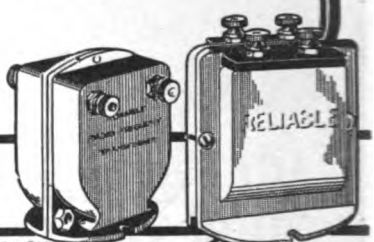
Fully enclosed, of the shielded type. List price $4.50 and $5.00. Ready for convenient mounting. Fully guaranteed.

Radio adjustable type transformers as follows:

No. 4 200-400 meters
No. 5 400-600 "
No. 6 200-500 " long range
No. 7 300-505 "

List Price $2.75 each. Static reduced to a minimum.

Dealers and Jobbers: Investigate the "Reliable" Business Boom



RADIO FREQUENCY AMPLIFYING TRANSFORMER

AUDIO FREQUENCY AMPLIFYING TRANSFORMER

The Reliable Parts Mfg. Co.
2819 Prospect Ave. Cleveland, O.

WEIGHS ONLY 8 OZ

The Scientific

THE PHONE IT TOOK A SOLID YEAR TO DESIGN

A $200,000.00 COMPANY stands squarely back of the guarantee on every *Scientific* headset

SEND NO MONEY!

20,000 TURNS EQUIVALENT TO 3,000 OHMS

$2.95 POST-PAID

Order TODAY by Postcard and Pay Postman on arrival

LOUD SPEAKER UNIT $1.95

We Guarantee The *Scientific* Headset to be the greatest value on the market. Try it for five days. If not satisfactory send it back and your money will be refunded immediately. Circular on request. Dealers wanted.

THE SCIENTIFIC ELECTRIC WORKS
98 Brookline Ave. DEPT. J **BOSTON, MASS.**

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Build your own set *with* Gilfillan Parts

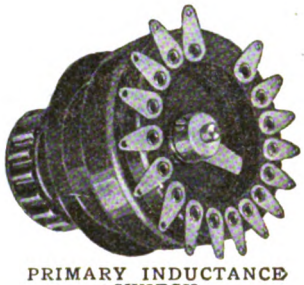
THE work is interesting, instructive and not difficult. Then too, the finished set will give you splendid results—*at low cost*—especially if you have assembled it with *Gilfillan* standard high-quality parts.

Gilfillan Radio Parts are the perfect combination of scientific design, accurate workmanship and best materials; so when you select *"Gilfillan"* you're certain of the inbuilt dependability of that part.

If your dealer does not handle this superior line, write us for name of nearest dealer, descriptive folder and list.

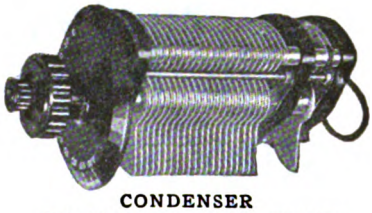
Genuine Gilfillan Radio Parts can always be identified by this trade-mark. Look for it.

Two New Gilfillan Radio Parts



PRIMARY INDUCTANCE SWITCH

15 point. Provided with solder lugs. Moulded brown bakelite black knob and dial.



CONDENSER

With Vernier and pigtail connection. Obtainable in 43 plate, as above, and 23 plate sizes.

Other Gilfillan Parts

Varicouplers (2 sizes)	Tube Sockets
Variometers (2 sizes)	Tube Socket Adapters
Air Condensers (3 sizes)	Detector Amplifier Units
Audio Frequency Transformers	Detector Units
Potentiometers	Vernier Air Condensers
Primary Inductance Switches	Filament Rheostats
Panel Switches	Vernier Rheostats
	Moulded Knobs, etc.

GILFILLAN BROS., INC.

1925 McGee St., Kansas City, Mo.
1815 W. 16th St., Los Angeles, Cal.
225 W. 57th St., New York, N. Y.

Licensees General Bakelite Co.

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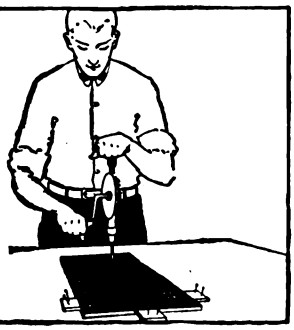


Radion being an insulation material especially made for wireless use, has the lowest phase angle difference, lowest dielectric constant, highest resistivity and supreme moisture, gas and acid repelling properties.

The Supreme Insulation

RADION Panels

are easiest to drill, saw or engrave with simple tools at home

18 STOCK SIZE PANELS

6 x 7	7 x 21
6 x 10½	7 x 24
6 x 14	7 x 48
6 x 21	9 x 14
7 x 9	10 x 12
7 x 10	12 x 14
7 x 12	12 x 21
7 x 14	14 x 18
7 x 18	20 x 24

American Hard Rubber Co.
11 Mercer St., New York

RADION

Panels-Dials-Knobs-Sockets-Insulators

BRANSTON RADIO

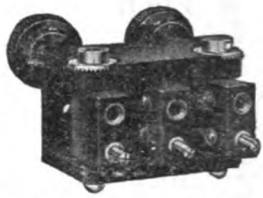
Branston D. L. Honeycomb Coils and Mountings Give Better Tuning

GREATER
Strength—
Clearness—
Selectivity

BETTER
Quality

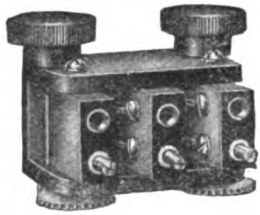
INSIST
ON THE GENUINE

Branston D. L. Honeycomb Coils are accepted as standard in regard to superior construction and electrical units of measurement.



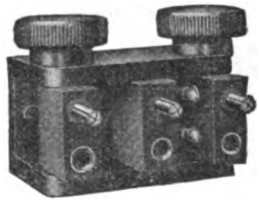
R-62 Three Coil Bevel Geared type. Back Panel Mountings. **$6.00**

Bevel gears provide very smooth operation and vernier adjustment. Made of Genuine Bakelite, complete with flexible leads. Arrow knobs show position of coils.



R-61 Three Coil Geared Type. Front Panel Mounting. **$5.00**

Substantial gears give vernier adjustment. Very neat appearance; made of Genuine Bakelite, complete with flexible leads.



R-73 Three Coil Bakelite Mounting. **$4.50**

Neatest three coil mounting on the market. Made of Genuine Bakelite and complete with flexible leads.

R-71 Two Coil Mounting. **$3.25**

Very neat and capable of smooth operation. Only two mounting screws required. Complete with flexible leads.

Hookup Circular Sent for 2c.

Compiled by experts and includes five good Honeycomb Coil "Hook-ups" and complete catalog of famous Branston Radio Apparatus. Write today. Give us name of your radio dealer. If he can't supply you, write.

All Branston Coils and Mountings are licensed under De Forest Patents.

Insist on the Genuine Branston "Standard of the World."

CHAS. A. BRANSTON, Inc.
811 Main Street **Buffalo, N. Y.**
In Canada—Chas. A. Branston, Ltd., Toronto, Ont.

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BROADCASTING

TRANSMITTING delicate electrical currents has been highly developed. Receiving them as sent is vital to your enjoyment.

No matter how efficient your receiving set may be, it rests with the headphones you buy to transform these currents into sound. Beautiful, clear and distinctive tones of music or spoken words cannot be reproduced by inferior headphones.

Twenty-five years of research and painstaking manufacture by the Holtzer-Cabot Electric Co. has produced for you the supersensitive No. 2 Universal Headset.

This light weight, sanitary set reproduces positively and faithfully with an exceptional purity of tone and extreme sensitiveness.

Holtzer-Cabot No. 2 Universal
The supersensitive phone
Holtzer-Cabot No. 4 National
The quality phone at a minimum price
Be sure and send for a copy of our booklet "What you should know about Radio Reception."

THE HOLTZER-CABOT ELECTRIC CO.
125 Amory Street, **Boston, Mass.**
6161-65 South State Street, **Chicago, Ill.**
Department B

Holtzer-Cabot
BUSINESS ESTABLISHED 1875

HEAD SETS

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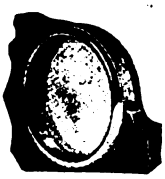
Vacuum Tubes Do Triple Duty
With Erla Synchronizing Transformers

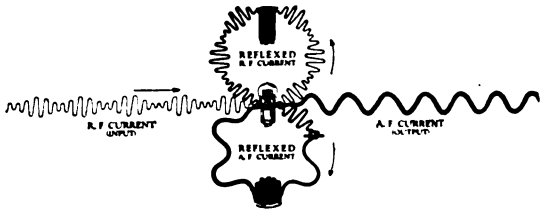
Perfect synchronization of received and reflexed r. f. currents make Erla radio transformers indispensable in reflex work. List, $5

Erla tested capacity condensers are unequaled in rigid, unvarying accuracy, so vital to success in reflex work. Eleven sizes, 35c to $1 ea.



Erla bezels greatly enhance the finest cabinet assembly. Telescoping rim, in bright nickel or dull enamel, fits any ⅛" to ¼" panel. List, 20c

Dealers and Jobbers—Erla progress constantly widens avenues of trade. Write for liberal terms and discounts



For the first time, the full efficiency of vacuum tubes is completely utilized and brought under control.

In Erla reflex circuits, tubes do triple duty, providing simultaneous amplification of radio frequency, reflexed radio frequency and reflexed audio frequency currents. Yet, so precise is the manipulation of this complex current flow, that the tremendous gains resulting are achieved without a single drawback.

Not only do Erla reflex circuits demonstrate decisive superiority in range and volume, but they are also unequaled in selectivity, purity of tone, and ease of control. Even the single-tube circuit provides far-flung loud speaker range, while the three-tube circuit surpasses costliest multi-stage units in transcontinental loud speaker reception. And the two-tube circuit is close behind.

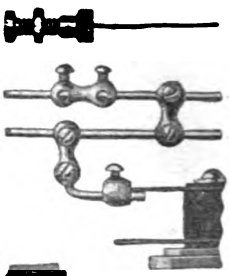
Essential to the operation of these circuits, and the secret of their success, are Erla synchronizing radio and audio transformers. Providing perfect synchronization of received and reflexed currents having the same phase characteristics, they assure tremendously magnified amplification without distortion.

Complete diagrams and descriptions of perfected Erla reflex circuits are set forth in Erla Bulletin No. 14, obtainable gratis from leading radio dealers. Or write us direct, giving your dealer's name.

Electrical Research Laboratories
Dept. R 2515 Michigan Avenue, Chicago

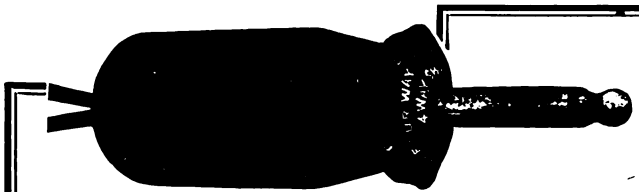
ERLA

Rectified radio frequency and reflexed audio frequency currents are accurately synchronized by Erla audio transformers. List price, $5



Difficult, dangerous use of soldering irons is eliminated by Erla solderless connections, saving time, temper and money. List, 5c ea.

Providing utmost sensitiveness with perfect stability, the Erla fixed crystal rectifier is uniquely adapted for reflex work. List, $1



The New 1924 Model "4-Way" Switch Plug!

Many refinements have been added to make this the best radio plug

—a switch plug which makes it possible to tune in through head set and switch in loud speaker by turning dial. Two head sets can be readily attached, or one head set and loud speaker. Both can be used at same time or either one alone. ***Order yours TODAY.***

$1.50

FOUR WAY CO., 29 Worthington St., Springfield, Mass.

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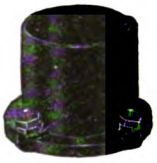
Na-ald Adapter No. 429
For UV-199 and C-299.
Tubes. Price 75c

It's the contact that counts

De Luxe No. 400
Price 75c

A CAREFUL examination will show that each contact in Na-ald sockets and adapters is of a wiping nature on a broad surface, and so designed that strong tension is permanent, no matter how often the bulbs may be removed or how much the connecting prongs in the tubes vary. Na-ald Sockets are moulded of Bakelite with uniform cross-section, cure and other engineering features incorporated, to avoid plate to grid losses and to insure that each tube develops its fullest efficiency.



Small Space No. 401
35c, 3 for $1.00

The new Na-ald dials combine rare beauty of design with highest efficiency in use. These dials are moulded from genuine Condensite in such a way that absorption losses are reduced to a minimum. Knobs are so shaped that fingers do not conceal clear numerals and graduation on the bevel of Na-ald dials.

Na-ald W.D. 11 No. 411
Price 75c

Na-ald Circuit Booklet packed with each Na-ald product

Write for "Why a Bakelite Socket?" and other descriptive literature

No. 450 Price 50c
Two-in-one Socket
For W.D.11 and
200 Tubes

Alden Manufacturing Company

Manufacturers of sockets and dials for every radio requirement

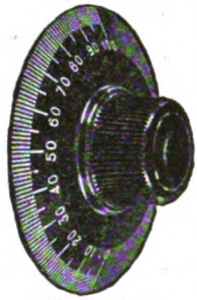
Dept. C 52 Willow Street

Springfield, Mass.

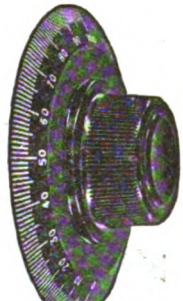
Cable Address, Aldenco

Na-ald Special
Socket No. 499
for UV—199 and
C. 299 Tubes. Price 50c

No. 3023—4
2 Inch
35c, 3 for $1.00



No. 3003—4
3 Inch
35c, 3 for $1.00



No. 3783—4
3⅜ Inch
Price 75c

NA-ALD

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Three Aces!

IN the experience of radio engineers, amateurs and experimenters there is a suggestion which clearly points the way to the battery buyer who desires the most fitting and practical combination of electrical energy, low cost per hour of service, long shelf life and uniformity of discharge.

"ASK ANY RADIO ENGINEER"

These "Three Aces," the famous Burgess "B" —the new *double strength* Radio "A" and our latest product, the Vertical "B" Battery are playing an important part in correct and dependable reception of radio broadcast. Each is

"A Laboratory Product"

Good dealers everywhere recommend and sell Burgess Batteries

BURGESS BATTERY COMPANY

Engineers—DRY BATTERIES—Manufacturers
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General Sales Office: **Harris Trust Building, Chicago**
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Branches: **New York Boston Washington St. Paul Kansas City New Orleans**

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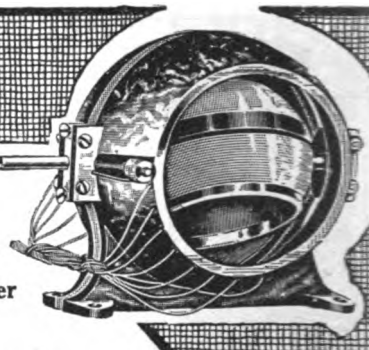
General Offices and Works: Niagara Falls, Ontario
Branches: Toronto, Montreal, Winnipeg, St. John



"Pioneer" Variocoupler $7.00

The first impression you get from looking at Pioneer Variocouplers and Variometers is that beyond doubt they are the most beautiful instruments yet devised.

The beautiful Bakelite in a grained mahogany finish has a richness that has never been equalled before.

The heavy copper wire, covered with green silk, gives a contrast that makes the instruments irresistible and adds tremendously to the beauty of any set.

The mechanical parts are no less wonderful. The hardware of heavy bronze—the close-coupled rotor and stator—the positive contacts, all demonstrate the highest mechanical skill and attention to detail.

A special feature is the winding of the variocoupler on the inside of the shell—which is original and exclusive with Pioneer.

Ask your dealer to show you these instruments. If he cannot supply, write us, giving his name and address.

PIONEER RADIO CORPORATION

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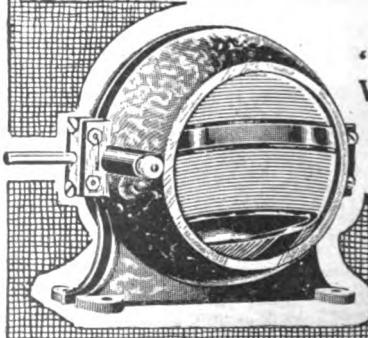
Chicago, Ill.....33 S.o. Clinton St.
Kansas City, Mo...208 Baltimore Bldg.
Minneapolis, Minn..705 Plymouth Bldg.
San Francisco.....623 Larkin St.



"Pioneer" Variometer $6.50

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The World's Most Popular Battery Charger

Nothing speaks so eloquently of HOMCHARGER satisfaction as the fact that thru sheer merit alone it has become the *standard* by which all other battery chargers are judged. Over 125,000 HOMCHARGERS already in use offer the most convincing proof that it is the most efficient, economical and fool-proof battery charger at any price.

A NEW TRADE-MARK FOR A TRIED AND PROVEN PRODUCT

Its phenomenal success has led to the introduction of many inferior and make-shift imitations. To insure our reputation and protect the buying public against substitution, the Radio De Luxe HOMCHARGER henceforth will be sold under a new Trade-Mark, viz:

GOLD SEAL HOMCHARGER

Retaining the same fundamentally correct operating principle and beautiful appearance of our Radio De Luxe model, it is a step nearer ultimate perfection through adoption of several construction refinements dictated by the policy of Progress.

HOMCHARGER'S 10 POINTS OF SUPERIORITY

1. **Simple**—Only one moving and wearing part, replaceable after thousands of hours use for $1.00. Will last a lifetime.
2. **Efficient**—Uses less than one-half the current of any bulb or liquid type rectifier. Will charge any radio or automobile battery for a nickel.
3. **Quick**—Its high charging rate of 7 amperes eliminates long waiting for battery to become charged. Will charge any "A" or "B" battery over night, or three times as fast as a 2-ampere machine.
4. **Clean**—No expensive bulbs to break or acids to spill or replace. No acid fumes. Charges without muss, fuss or bother.
5. **Dependable**—Tungsten contacts insure continuous operation—prevent sticking and stopping.
6. **Fool-Proof**—Can be operated by anyone. Attach to lamp socket and connect battery either way, it will always charge. High-grade ammeter eliminates guess work.
7. **Safe**—No danger of shock or fire. Tested and approved by Fire Insurance Underwriters everywhere. Gives tapering charge—will not overheat or injure battery.
8. **Beautiful**—Mahogany and Gold Finish.
9. **Unqualifiedly Guaranteed.**
10. **Popularly Priced**—Retails at $18.50 complete ($22.00 Canada). No extras to buy. Sold by all dealers.

FREE BROADCASTING LIST. Send to-day for Free List of Broadcasting Stations, and Circular Describing the Gold Seal Homcharger.

DEALERS! JOBBERS!

GOLD SEAL HOMCHARGERS will outsell any other radio device this season. "GOLD SEAL Business Builders" illustrates many attractive sales helps and explains how we are prepared to co-operate with the Trade in making this a "HOMCHARGER Year." Send for your copy and Trade Discounts TODAY.

Insist on the GOLD SEAL

LOOK FOR IT

GENUINE GOLD SEAL HOMCHARGER REG. UNQUALIFIEDLY GUARANTEED

It is your protection against substitution. When buying *order by name* and *verify by the GOLD SEAL*, which appears on the carton as well as the nameplate.

The Automatic Electrical Devices Co., 132 West Third St., Cincinnati, O.

Largest Manufacturers of Vibrating Rectifiers in the World

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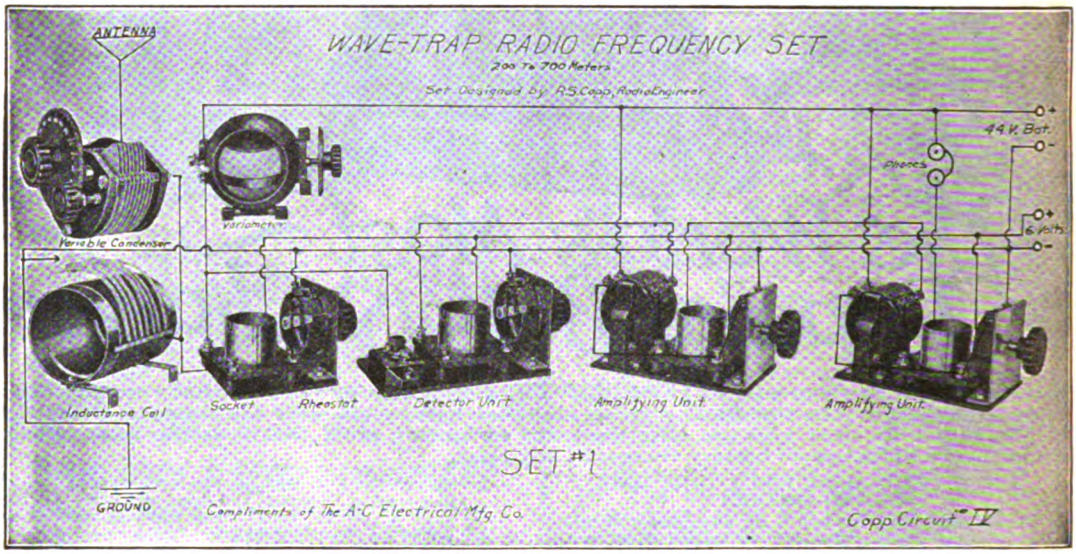
SAVE $75.00

By building your own set using this wonderful circuit and A-C DAYTON Radio Products



This high class set as shown above would cost $125.00 but we are offering you the opportunity of building this same set at a cost of not over $50.00. All A-C Dayton units are wired and complete, ready for connection in the circuit. This set has one stage of Radio-frequency amplification and two stages of Audio-frequency, producing a set with extreme long range and good signal strength.

A-C Dayton Radio Products represent a complete line of radio parts, and are so designed as to be co-ordinated in any type of radio circuit, producing a beautiful and efficient set at a reasonable price. If your dealer does not have full information on circuits, write us direct or have him send for full description and our latest catalog describing the many uses of our parts and units.

THE A-C ELECTRICAL MFG. CO. **DAYTON, OHIO.**

Makers of Electrical Devices for over 20 years

RADIO FANS

Tune in on station

W E A F (New York)

every Thursday at 8:50 P. M. and listen to a story or article selected from

HEARST'S

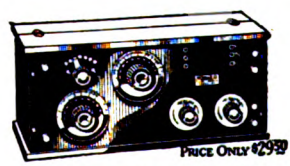
INTERNATIONAL

This is one of the most popular weekly features "on the air"

FREE

Write for free copy of Radio Reprint No. 1—it contains a complete Cappy Ricks story by Peter B. Kyne.

Address Radio Editor, 1-A, Hearst's International Magazine, 119 West 40th Street, New York City.



MIRACO GETS 'EM 1500 MILES AWAY

At the low prices shown below you get the efficiency of sets costing three times as much.

These radio frequency receivers—pick up stations over 1,500 miles away under good conditions—everywhere.

Operate either on DRY CELLS or storage battery.

Cabinets of solid mahogany and workmanship the finest throughout. Order direct or send for bulletin.

Two tube outfit, as shown above, for use with headphones only $29.50

Four tube outfit for loudspeaker or headphones... $54.50

DEALERS AGENTS—*write for proposition quickly—it's a winner.*

THE MIDWEST RADIO COMPANY

812 Main Street **Cincinnati, Ohio**

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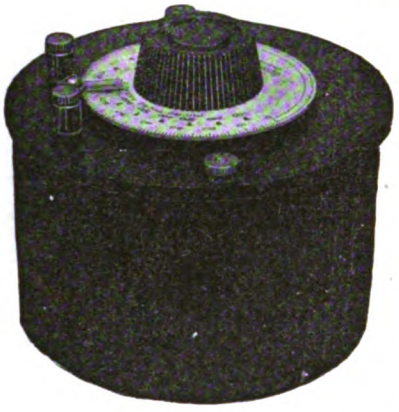
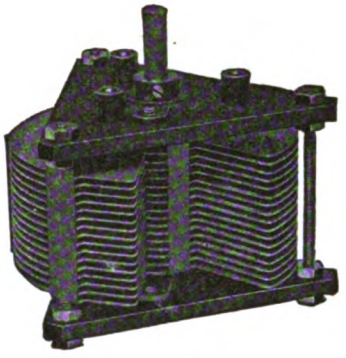
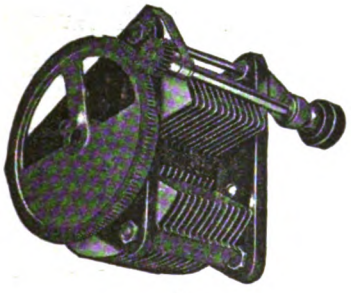
Sharpen Your Tuning







A

General Radio Co. Type 247 Variable Air Condenser.

NO operator of a radio receiving set need be told of the advantage of sharp precise tuning. It is not always clear, however, how this may be obtained. After a good tuning coil has been chosen look to the CONDENSER for the answer.

Years before radio became a popular pastime, the General Radio Co. was manufacturing low loss, scientifically designed condensers for use in such discriminating laboratories as those of the Bureau of Standards, Naval Radio, General Electric, Westinghouse, Western Electric and the leading educational institutions of the country. The efforts of these years of research work in our own laboratory have resulted in the design of a condenser incorporating the best features in design and at the same time available at a price substantially lower than other good quality condensers.

Here are some of the important features: Sharp tuning through low loss design using hard rubber properly placed—Heavy brass plates soldered together keeping capacity constant and greatly reducing danger of shortcircuiting—Low zero capacity giving wide wave length range—A CONTINUOUS VERNIER formed by a gear and pinion combination. Only one setting required.

Made in three sizes, 250, 500 and 1000 m.m.f. to fit every circuit. Mounted condensers are fitted with calibrated direct reading capacity dial.

Prices $3.00 to $8.50. Send for Educational Pamphlet, "Quality Condensers" and new RADIO BULLETIN 916U.

GENERAL RADIO CO.

Manufacturers of Electrical and Radio Laboratory Apparatus

MASSACHUSETTS AVENUE AND WINDSOR STREET

CAMBRIDGE, MASSACHUSETTS

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$14.50

Seven Reasons for C. I. C. Supremacy

1. High volume efficiency.
2. Superior quality of reproduction.
3. Attractive appearance.
4. Convenient size.
5. Adjustable air gap.
6. Unconditional guarantee.
7. Moderate price.

Our booklet "Loud Speaker Facts" will prove these points to you. A copy free on request.

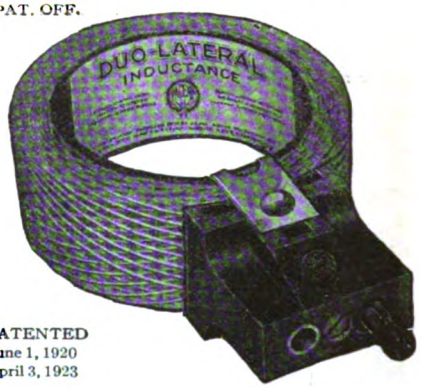
CONNECTICUT INSTRUMENT COMPANY
Stamford, Connecticut

Canadian Distributors: Perkins Electric Ltd., Toronto, MONTREAL, Winnipeg.
New York Representative, Mr. C. B. Cooper, 154 Nassau St.
New England Representative, Hill Specialty Sales Co., Boston.
Chicago Representative, Stackhouse and Allen, 559 W. Monroe St.

ANNOUNCEMENT

Genuine PACENT *Duo Lateral Coils Mounted

*REG. U.S. PAT. OFF.



PATENTED
June 1, 1920
April 3, 1923

A Complete Line of Improved Coil Equipment

I. **PACENT COIL PLUG**—Quick to connect. Vise grip on coil. Set screw connections with coil leads. Cat. No. 110. ***Price $1.00.***

II. **COIL PLUG RECEPTACLE**—an improved receptacle. Special Pacent feature to insure tight contact. Cat. No. 111. ***Price $1.00.***

III. **MOUNTED COILS**—The genuine Pacent Duo Lateral Coils equipped with improved plug. Sizes MS 25 to MS 1500. The perfect combination. ***Prices $1.40 to $3.85.***

IV. **MICROMOUNT**—a de luxe 3 coil mounting affording fine vernier coupling adjustment. Cat. No. 115, with base, ***$9.50.***
Cat. No. 115A, same as No. 115 less base and binding posts, ***$8.00.***

V. **MICROCOUPLE RECEPTACLE**—a single receptacle permitting vernier adjustment of coil. Cat. No. 118. ***Price $2.00.***

VI. **PANEL RECEPTACLE**—a fixed receptacle for panel mounting principally for use with Cat. No. 118. Cat. No. 119. ***Price $1.50.***

Duo Lateral Coil Labeled PACENT is the GENUINE

Don't Improvise—"PACENTIZE"

Send for Booklet P-11 describing Pacent Radio Essentials

PACENT ELECTRIC CO., Inc.
22 Park Place New York, N. Y.

Sales Offices:
Chicago, Philadelphia, St. Louis, Minneapolis Washington, D. C., San Francisco, Jacksonville

Pacent
RADIO ESSENTIALS

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The "A" Battery's Power in Your Radio Receiving Set

THIS IS NUMBER TWO OF A SERIES

THE sole purpose of the "A" Battery in your Radio Receiving Set is to furnish current to heat the filaments of the tubes.

And this can be done satisfactorily only by an "A" Battery that supplies an adequate steady current.

Anticipating the popularity of the dry cell tube in Radio, and realizing that it required a Dry Cell capable of standing up under service conditions differing from what dry cells are called upon to meet in other fields, the National Carbon Company developed the Eveready Radio Dry Cell specifically for this new use.

A dry cell gives its maximum service only when designed especially for the work it is intended to perform. There are for dry cells several uses which are so alike that one type of cell serves for all. This is the field covered by the ignition or general purpose dry cell.

The conditions encountered in Radio are different from the conditions grouped together under the term "general purpose." And while the general purpose dry cell performs well as an "A" Battery, it was found possible to produce a Dry Cell "A" Battery capable of delivering more service on Radio loads.

Thirty years of dry cell experience and an immense research organization resulted in the superior Eveready Radio Dry Cell. One of the outstanding features of this special cell is that while it will last much longer when used as an "A" Battery, it is no larger than the standard dry cell.

The increased service life of the Eveready Dry Cell "A" Battery greatly offsets the slight increase in cost; so this battery is not only the best, but it is the most economical you can buy. "The Story of Eveready Dry Cell Radio 'A' Batteries," which tells how to use Dry Cells to the greatest advantage with the various dry cell tubes now available, will be sent to you free on request.

* * * *

The "A" Battery gives power to your Radio Receiving Set. Eveready Batteries—especially made for Radio—serve better, last longer, give better results.

Note: This is number 2 of a series of informative advertisements which will appear in this magazine. They are designed to help users get the most out of their Batteries and their Radio Sets. If you have any battery problem, write to G. C. Furness, Manager Radio Division, National Carbon Company, Inc., 128 Thompson Ave., Long Island City, N. Y.

POWER

for Your Radio Set

Eveready Dry Cell Radio "A" Battery (No. 7111)

Directions and wiring on the jacket tell just how to use this battery with the different dry cell tubes.

This special Radio Cell is also available in two and four cell multiple batteries for receiving sets employing from two to four WD-11 or WD-12 tubes.

Other Radio Batteries

Eveready Storage "A" Batteries—best suited for filament heating of all Radio Tubes not especially designed for dry cells. The quality storage battery with the long life plates, $15 to $20.

Eveready "B" Batteries—the life of your Radio.

Eveready "Three" Battery—3 cells, 3 purposes.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, Inc.

EVEREADY
Radio Batteries
—they last longer

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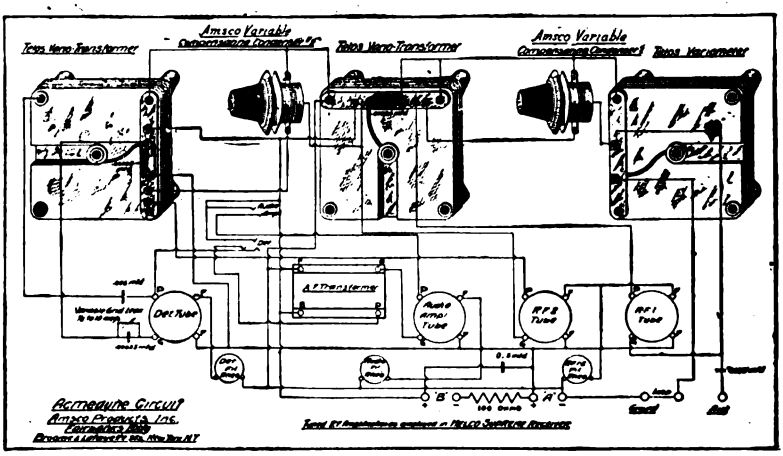
THE ACMEDYNE CIRCUIT

as described in detail by Mr. Laurence Cockaday in his article on Tuned Radio Frequency Amplification in a recent issue of Popular Radio, and praised and recommended by many other leading Radio Publications in the United States and Canada, is employed in the



MELCO-SUPREME

The Radio-Frequency Amplifying Receiver that—

Price Only $140

Complete knock-down parts for Melco-Supreme including drilled engraved Bakelite panel and solid mahogany cabinet PRICE $90

Operates with merely a 10 FT. WIRE. Not even a ground necessary.

Offers exceptional CLARITY without the slightest lost of tone quality.

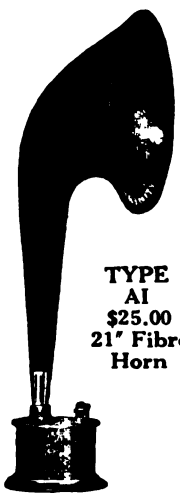
Assures unusual program SELECTIVITY through its single tuning adjustment.

Affords real LONG DISTANCE by covering all Broadcasting ranges from 180 to 610 Meters.

Write for our complete literature illustrating and describing MELCO-SUPREME in detail, and also our entire line of AMSCO Parts.

AMSCO PRODUCTS, Inc.

BROOME and LAFAYETTE STS. DEPT. PR NEW YORK CITY



TYPE AI $25.00 21" Fibre Horn

The TRINITY LOUD SPEAKER

The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

For sale by good dealers. Literature upon request.

TRINITY RADIO CORPORATION
446½ Tremont Street, Boston, Mass.

BATTERY CHARGING RECTIFIER and LARGE STORAGE BATTERY $20

Battery Charger of well known make connects to any lamp socket. Recharges battery overnight at 5 amp. rate. Furnished with long charging cable with battery clips. Battery is 6 volt, large capacity. Specify whether used for auto or radio. Guaranteed for one year. Act at once, as we have only a limited number of this combination offer at this bargain price. Send money order, or will ship C. O. D. on 25% deposit.

BELMONT BATTERY CO.
3231 Sheffield Ave. Chicago, Ill.

RADIO FANS
Rejoice when using these pneumatic phone cushions. They gently hug the ears, shutting out all room noises. Fits any type headset Money back guarantee if you are not satisfied

SENT ANYWHERE POSTAGE FREE $1.00 PR.

FANS List of Bargains **FREE**

RADIO BARGAINS
17 N. LA SALLE ST - CHICAGO

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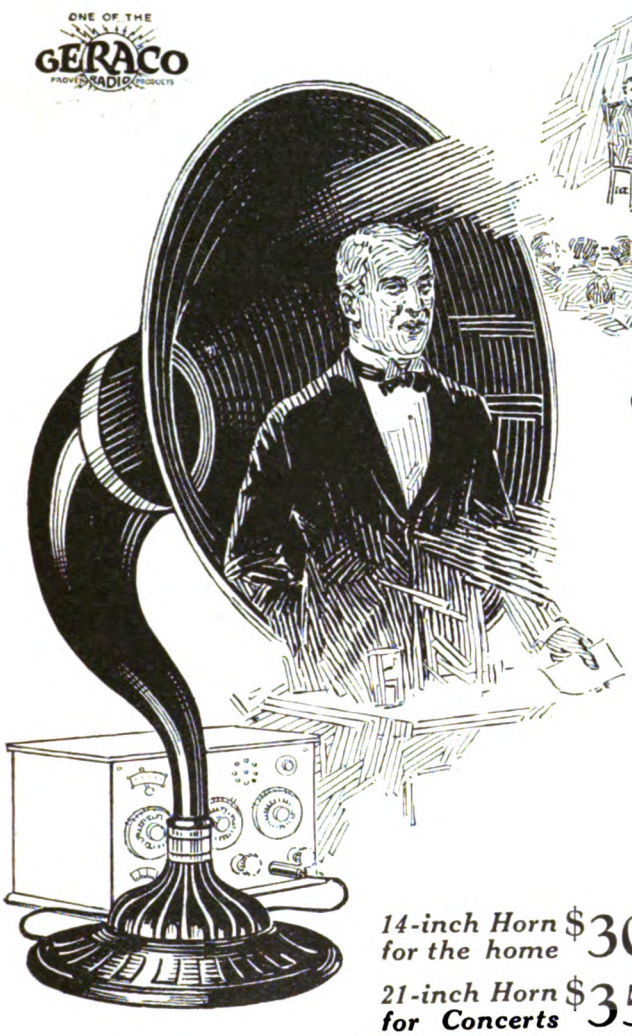
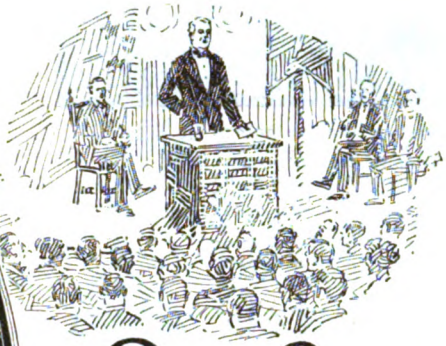
ONE OF THE
GERACO
PROVEN RADIO PRODUCTS





So far—yet so near!

THE Mayor—the Senator—the Governor — the President — or other prominent speaker.

Hear him in your own home as clearly and distinctly as he is heard by audiences, scores of cities away! With MUSIC MASTER!

Have the family pull up chairs and listen to discussions of national topics by leaders of the state and nation. Through MUSIC MASTER, the most *natural* of radio reproducers.

Attached to any good receiving set, MUSIC MASTER *completes* the enjoyment of radio. It is the confortable, the unselfish, way to hear radio. Hear MUSIC MASTER, with its unrivaled *wood* horn, at your radio dealer's.

Dealers Everywhere

14-inch Horn $30
for the home

21-inch Horn $35
for Concerts

GENERAL RADIO CORPORATION

Makers and Distributors of High-Grade Radio Apparatus

CHICAGO — PHILADELPHIA — PITTSBURGH

S. W. Cor. 10th & Cherry Sts.

Music Master
RADIO REPRODUCER

47

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IF YOU CAN'T BUY THEM AT YOUR DEALER'S SEND DIRECT TO US

"Red-Heads" are *guaranteed* radio phones. You run no risk when you buy them. Money back if, after 7 days' trial, you're not satisfied that they're the *best* receivers on the market at the price. Why not act *right now* and get a pair? It'll mean getting the *maximum* from broadcasting from the day you put them into use.

RED-HEAD RADIO RECEIVERS

These remarkable head-sets are made by The Newman-Stern Co., one of the *pioneer* radio manufacturing houses in America.

JUST OUT

The new 1924 Model F

$6.50 PER PAIR Complete

This is the standard 3,000 ohm "Red-Head." The 1924 Model F has eleven improved features. Sensitive and fine-toned; aluminum case; famous brown-red ear caps; military headband; high-grade cord.

The new 1924 "Red-Head" Jr.

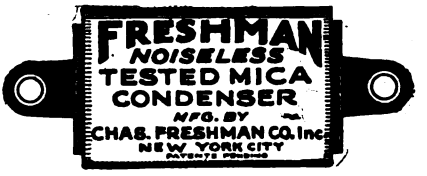
$5.00 PER PAIR Complete

The Junior Model has most of the quality features of the standard Model F here described. The resistance is 2,000 ohms per set instead of 3,000 ohms. A remarkable value.

"Red-Heads" sent prepaid on receipt of price if you are unable to get them at your dealer's.

THE NEWMAN-STERN COMPANY
Dept. PR Newman-Stern Bldg. Cleveland

The Condenser Sensation of Modern Radio



Through the accuracy and dependability of Freshman Condensers, hook-ups and circuits have been perfected which have completely revolutionised the art of Radio Reception.

These little Storers of energy and rectifiers of Radio Current are the very heart of a well-built radio set.

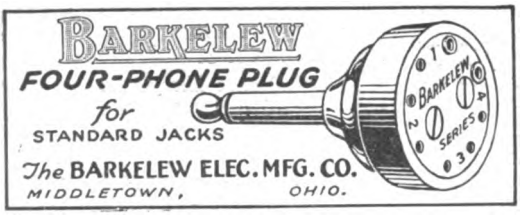
The proper fixed condenser will make all the difference in the world in the reception, clarity and selectivity your set affords.

Capacity	Each	Capacity	Each
.0001	$ .35	.0025	$ .50
.00015	.35	.003	.60
.00025	.35	.0035	.70
.0002	.35	.004	.75
.0003	.35	.005	.75
.00035	.35	.006	.75
.0005	.35	.007	1.00
.0006	.40	.008	1.00
.0008	.40	.01	1.00
.001	.40	.015	1.50
.0015	.40	.02	2.00
.002	.40	.025	2.50

The FRESHMAN is so designed that constant equal pressure is exerted on the condenser plates over the entire area. They are the only condensers that do this and therefore the only condensers that avoid noises, which are due to variable pressure on the plates.

At your dealers, otherwise send purchase price and you will be supplied without further charge.

Chas. Freshman Co. Inc.
Radio Condenser Products
106 SEVENTH AVE., NEW YORK



WORKING KNOWLEDGE
OF RADIO CODE AND LICENSE

One Week. Our students master Code 15 Min. Ten word Speed 3 Hours. Records 100 Licensed Students in 12 Districts One Dime. Best 40 Records free. Ask verification. Simple Instructions that Instruct, only $2.00.

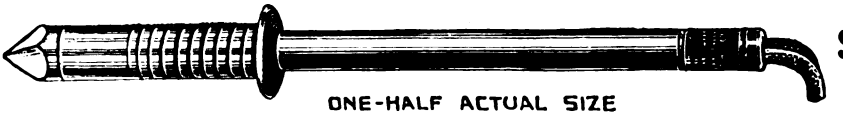
DODGE RADIO SHORTKUT, Dept. P Mamaroneck, N. Y.

METALECTRIC SOLDERING IRON

(*The All-Metal Quality Instrument—Guaranteed*)

"A solution to the small soldering problems of the discriminating assembler"

Renewable Tip



$5.50

ONE-HALF ACTUAL SIZE

Unbreakable Construction—Economical Operation on any Electric Circuit

from your dealer or write

POST ELECTRIC CO., Mf'rs. (Instruments Division) 30 East 42nd St., N. Y. C.

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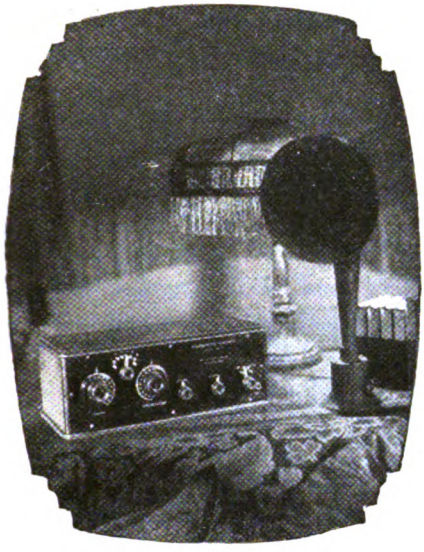

The Thrill of Great Distance

For 12 years, Tuska-built radio receivers have been famous for long range reception, and have made records that are unsurpassed.

F. R. Alger of Prince Albert, Saskatchewan, Canada, says, "I am sending a list of 67 stations, a total distance of 78,200 miles away. You will realize that all stations are far removed from us; most of them have to come over 1,000 miles. The Tuska is remarkable for simplicity of tuning. It has been a source of great satisfaction."

You needn't know a thing about radio

Night after night, year after year, a Tuska Radio will bring fine entertainment into your home, at a trifling expense for operating.

You need not depend upon good-natured friends with radio experience to help put a Tuska in your home. Surprise them all by doing it yourself. It is easy to install your own "listening post," and pick up your choice of the wonderful concerts that fill the air.

At pleasure you can tune out any program and tune in another more to your liking. The same Tuska that fills your rooms with clear, unmarred music and distinct speeches will also pick up broadcasting from stations 2,000 or more miles away.

Some of the most experienced radio inventors and engineers in this country designed and built the Tuska. It is right, forever, and needs no tinkering. Have no fear that it will become obsolete. A Tuska set bought today will be serviceable for years to come.

Tuska Popular No. 225

3-bulb Regenerative Receiving Set

Piano finish mahogany cabinet. Amplifier switch. Concealed binding posts. Armstrong circuit, licensed under Patent No. 1,113,149. Price $75, without bulbs, batteries or loud speakers.

Ask for special circular No. 15E, describing this set.

TUSKA TRADE MARK REG U.S. PAT. OFF. RADIO

The C. D. Tuska Co.

Hartford, Conn.

TUSKA RADIO

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REFLEX SUPERIORITY! RESULTS GUARANTEED!

Are you getting the best from your Reflex Set?

MPM — MILLION POINT MINERAL — THE WORLD'S GREATEST RADIO CRYSTAL

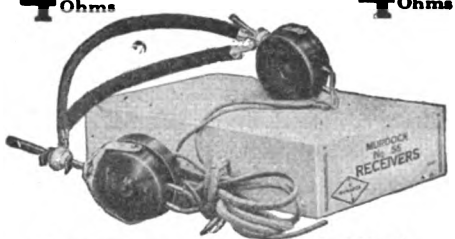
M. P. M. (MILLION POINT MINERAL) CRYSTAL

—tested and guaranteed—has proven itself the superior crystal for Reflex Reception. M. P. M. will not corrode or burn out; does not lose its sensitiveness; and clear, musical, economical reproduction is assured. Unsolicited testimonials show marvelous long-distance records, both with and without amplification. Ask your dealer for M. P. M., or send us 50 cents for two unmounted, or 70 cents for two mounted; and, in addition to crystals, we will send you diagram of a reflex circuit that we guarantee will give absolute satisfaction.

M. P. M. SALES CO., Dept. PR, 247 So. Central Ave., Los Angeles, Cal.

MURDOCK HEADPHONES

$4.00 2000 Ohms — **$4.50** 3000 Ohms



These new low prices make Murdock Headphones a more wonderful value than ever. Standard for over 19 years. Satisfactory service always. Get a pair from your dealer.

A NEW MURDOCK PRODUCT
MULTIPLE PHONE PLUG JACK **$1**
(Cord Tip Type)
Enables you to have four pairs of headphones connected at once. GET ONE

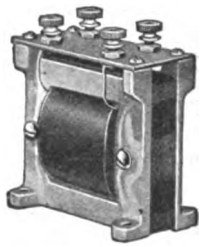
At All Dealers
WM. J. MURDOCK CO.
354 Washington Ave. Chelsea, Mass.
Sales offices: Chicago & San Francisco

H&H Radio Material

Nutmeg Brand

Based on 30 Years' Manufacturing and Electrical Development-Work

Try the new H & H Transformer W306—with a turn ratio of 6 to 1—in combination with our W303: turn ratio 3 to 1. The result will emphasize to you the "*why*" of this latest addition to the H&H Radio Family!



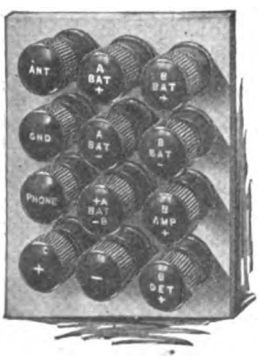
EVERY H&H (Audio Amplifying) Transformer is tested, before shipping, with 1500 volts potential between the primary and secondary winding; also between these windings and the core. This test certifies to the durability and integrity of workmanship, though technical data will be sent gladly if requested. Price of H&H Transformer—

W303, Turn ratio 3 to 1 . . . . . $4.50
W306, Turn ratio 6 to 1 . . . . . 5.00

Write for new 32-page catalogue showing complete Radio Line and three practical photographed hook-ups

We will carefully fill your order direct if you cannot get the goods locally. Send us your Dealer's name and address and secure a photo of an excellent one-step dry cell hook-up, free.

THE HART & HEGEMAN MFG. CO.
HARTFORD, CONN.



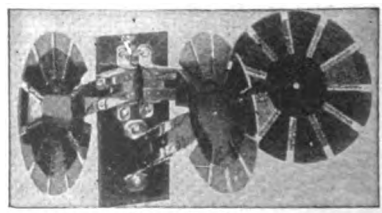
EBY ENGRAVED POSTS

Have non-removable tops.

They'll look classy on your set because the engraving will match your dials.

For sale by Dealers everywhere

The H. H. Eby Manufacturing Co.
Philadelphia, Pa.



Patent Pending

The GOODMAN is the niftiest short wave tuner on the market. Awarded certificates of merit. Our pamphlet tells all about it. Send for one. Price $6 and PP. on one pound.

L. W. GOODMAN, Mfr., Drexel Hill, Pa.

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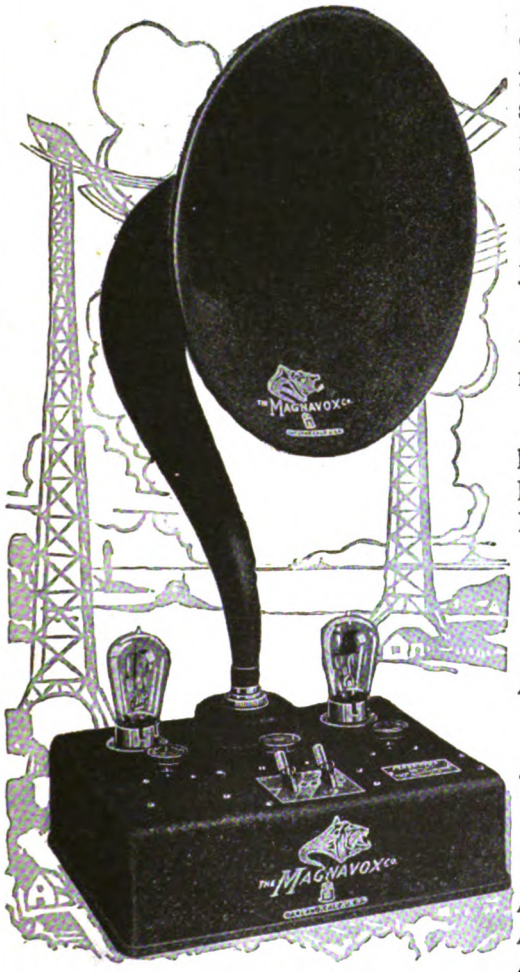
Magnavox Radio

The Reproducer Supreme

SO simple in operation that any Radio user can obtain perfect results—so sensitive and flexible in scope that the professional will find it fully responsive to every requirement—the new Magnavox Combination Set A1-R or A2-R brings a degree of radio usefulness and enjoyment never before attained.

Every condition in the art of radio reproduction is most successfully met by Magnavox apparatus.



The New Magnavox Combination Sets A2-R [2-stage] and A1-R [1-stage] insure the utmost in convenient, home radio reproduction.

Magnavox Reproducers

R2 with 18-inch curvex horn . $60.00
R3 with 14-inch curvex horn . 35.00
M1 with 14-inch curvex horn. Equipped with binding posts and a five foot flexible cord; requires no battery for the field. 35.00

Magnavox Combination Sets

A1-R consisting of electro-dynamic Reproducer with 14-inch curvex horn and 1 stage of amplification 59.00
A2-R consisting of electro-dynamic Reproducer with 14-inch curvex horn and 2 stages of amplification 85.00

Magnavox Power Amplifiers

A1—new 1-stage Power Amplifier 27.50
AC-2-C—2-stage Power Amplifier 55.00
AC-3-C—3-stage Power Amplifier 75.00

Magnavox Radio Products can be had of good dealers everywhere. 32-page catalog sent on request.

THE MAGNAVOX CO., Oakland, Cal.

New York Office: 370 Seventh Ave.

PERKINS ELECTRIC CO., LTD., MONTREAL, CANADIAN DISTRIBUTORS

11-R

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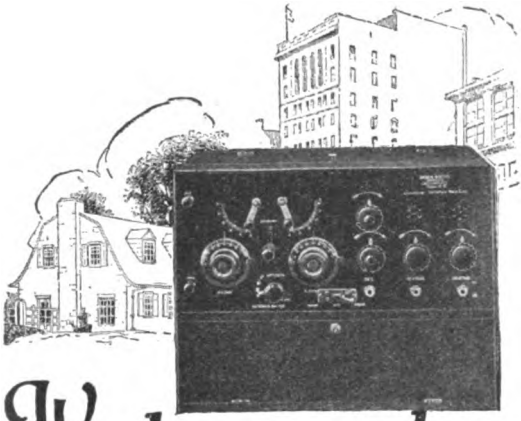

Works everywhere -city or country-

"Local Conditions" do not exist where Moon Satterlee Antennaless Radio is installed. Here is a set which brings distortionless speech and music to you no matter where you live or how severe the local conditions. The Moon is operated by simply grounding to a water pipe or radiator—no antenna, loop or indoor wire is necessary.

Stations within a conservative 1000 mile radius are regularly received with a non-power loud speaker on this set.

It is the ideal set for use in apartments, automobiles, yachts or railroad trains where an antenna is not practical. Extremely sensitive, unusually receptive, yet simple to operate.

Write today for our folder "California or Newark"

DEALERS:—Ask about our franchise

MOON RADIO CORPORATION
501 Steinway Ave., Long Island City, N. Y.

In Canada: Continental Equipment Co., Ltd., New Birks Bldg., Montreal, Quebec

MOON
Satterlee
antennaless
—RADIO—

This book puts you ahead of the crowd

You know the A B C of radio—now take the next step. Learn how to apply the fundamentals so as to greatly improve your results. Get the latest on scientific reception: build a transmitter. Your difficulties will vanish like magic before the lucidity of Mr. Ballantine's explanations and clean-cut diagrams. Two previous editions of this work bought out by thousands of enthusiastic amateurs. After reading this condensed table on contents, send along the $2—get ahead of the crowd.

Radio fully covered under these headings

PRINCIPLES — elementary theory of radio waves, etc.
TUBES — Audion as detector, amplifier, oscillator.
ANTENNA — various types; grounds and counterpoises.
TRANSMITTERS — circuits, details for building, operating.
SOURCES OF POWER — transformers, rectifiers, filters, batteries.
RECEIVERS—all types, super heterodyne, r. f. amplification.
GENERAL INFORMATION—laws, ethics, societies, etc.

Cloth bound, 296 pages, 153 cuts—the boiled down experience of 15 yrs. Many features not found in other publications.

Third Printing **$2** **POSTPAID**

Tear out coupon—*before you forget*

DAVID McKAY CO.,
S Washington Sq.,
Philadelphia

Enclosed Two Dollars is for the book—Radio Telephony for Amateurs, third printing. Please send postpaid—with the understanding that if not entirely satisfied, I may return the book within five days and have my money returned.

NAME .....

ADDRESS .....

.....

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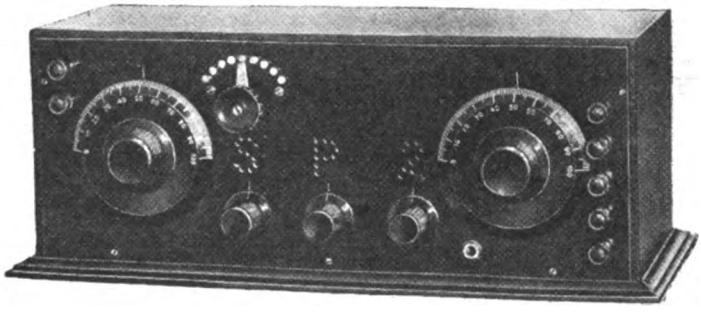
S P 2

1. Unlimited range
2. Perfect reproduction
3. Simplicity of operation
4. Genuine entertainment
5. No large antenna needed
6. Beautiful workmanship
7. Factory guarantee

W.E.A.F.	W.H.A.S.
W.O.R.	W.H.B.
K.D.K.A.	W.D.A.P.
W.F.I.	W.W.J.
W.D.A.R.	W.L.A.G.
W.L.W.	W.O.C.
W.S.B.	K.S.D.
P.W.X.	W.H.A.B.
W.J.A.Z.	K.F.C
K.Y.W.	



THE S. P. 2 Receiver stays sold, minimizes service expenses, unlimited range offering good volume and good distance, absolutely guaranteed. What more can you ask, Mr. Radio Business Man? Your letter head brings our proposition.

Catalogue 101A:—To "Radio Fans" on receipt of 10 cents

PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Avenue **Pittsburgh, Pa.**

S P 2

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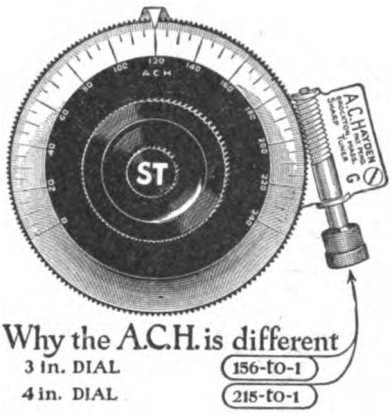


USE A.C.H. SHARP TUNER DIALS

Why the A. C. H. is different

3-in. DIAL (156-to-1) 4-in. DIAL (215-to-1)

Positive movement, no friction to slip, and no back lash in the spiral machine cut worm gear. (Not Moulded.)

Your Choice of

Rough tuning with dial or one thousandth of an inch in either direction with the Sharp Tuner Knob. Both controlled by center Knob ST.

Eliminates a vernier condenser. Locks instrument automatically. Dial grounded, reducing body capacity.

Money Back Guarantee

Price A. C. H. 3-inch Dial, complete.....$2.50
Price A. C. H. 4-inch Dial, complete..... 5.00
Regular fitting 5-16 inch hole, ¼-inch and 3-16 inch Bushings, 5c each extra. 10c for all.

Free Plan with mail orders on request

READ THIS LETTER

A. C. Hayden Radio & Research Co.,
Gentlemen:—

Please send me collect one of your ACH Sharp Tuners with 4-inch Dial by mail C. O. D.

We are owners of Radio K. Q. P. the oldest upstate broadcasting station in Oregon. We have been using your ACH Tuners for over a year having purchased three from the Blue Diamond Electric Co. of this city. We have found them entirely what you claim for them and although we did not like the proposition of having to cut down the shafts of our Variometers and Condenser, we found that the results justified the sacrifice of about half an inch of shaft.

With the aid of these Tuners on a 3-inch Circuit Regenerative Set the tuning is so close that signal strength nearly resembles that obtained on a Super Heterodyne Set. We propose to use the 4-inch Dial on a Condenser shunted across a box of special design, wound spider-web style, which is not only very directional but also extremely critical, so much so in fact, that the ordinary Vernier Condenser is unreliable. We want the 4-inch ACH Tuner for a ¼-inch shaft.

Please forward at your earliest convenience.

Yours truly,
HUGH G. BALL,
Radio Station Hood River News.

July 9, 1923.

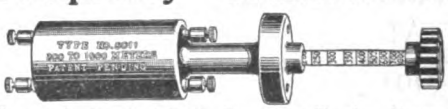
Full information on request. Mail orders sent prepaid in U. S. A.

A. C. HAYDEN RADIO & RESEARCH CO., 25 East Battle Street Brockton, Mass., U. S. A.

THE DAYTON FAN & MOTOR CO.
DAY-FAN
DAYTON, OHIO, U. S. A.

DAY-FAN
Audio Frequency Transformers
Bakelite Variocouplers
Bakelite Variometers
Vernier Condensers
5, 10, 20, 30 Ohm Rheostats
Potentiometers
Knobs and Dials
Wave Length Adapters

Tuned Radio Frequency Transformer



For use in Standard Radio Frequency Circuits—Neutrodyne Circuits—Reflex Circuits. Tunes to any wave length between 200 and 1000 meters.

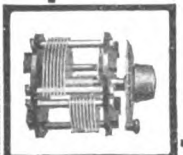
Don't overlook the fact that many of our best broadcasting stations have been assigned new wave lengths.
Every piece of Day-Fan Radio Apparatus is designed to operate over the entire public broadcasting range.

Write for 1923-1924 Catalog

The Dayton Fan & Motor Co.

Dayton, Ohio
Established 1889

DAY-FAN
Complete Detector Units
Complete Audio Frequency Amplifying Units
Complete Radio Frequency Amplifying Units
Mounted Variocouplers
Mounted Variometers


CONDENSER

VARIOCOUPLER

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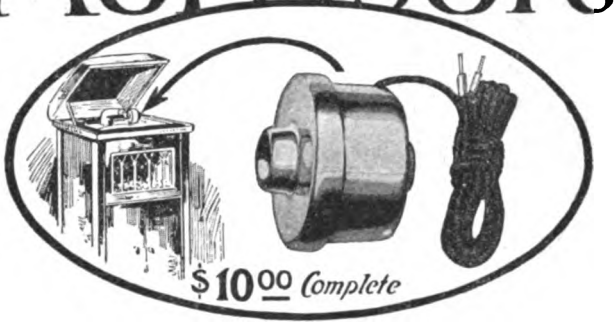
Morrison



Loud Speaker

RADIO SATISFACTION

True enjoyment of Radio begins when you and your family can sit comfortably in your living room and listen to all broadcasting reproduced in Clear, Full Volume. No annoying rattles, no harsh vibrations, no need for constant adjusting and fussing.

Morrison Loud Speaker gives you that kind of Radio satisfaction and pleasure, when attached to either your

PHONOGRAPH OR HORN

Attach the Morrison Loud Speaker to the tone arm of your phonograph—takes only a moment—and you have the benefit of the excellent phonograph sound box. Or attach it to any horn.

A little dial on the back of the Morrison Loud Speaker adjusts the tone from soft, mellow notes, to full-volumed, clear notes.

There is nothing to get out of order. Any one can use this wonderful radio unit with the same perfect results as an expert.

Order from your dealer, or send direct to us if your dealer cannot supply you.

DEALERS

If you are interested in one of the fastest-selling Radio units on the market, write or wire for our proposition—it is interesting.

Satisfaction guaranteed or your money back.

Price complete with 5 foot cord

Nickel Plated Model - - - - - - **$10.00**

Gold Plated Model - - - - - - **$15.00**

Write for illustrated catalog

MORRISON LABORATORIES, INC.

345 JEFFERSON AVE., EAST, DETROIT, MICH.

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Have your Dealer show you a "MICROSTAT"

A SUPER VERNIER RHEOSTAT

$3.00

And worth it

Premier "MICROSTAT" represents the highest state of development yet obtained in the Radio Rheostat field and operates or functions quite differently from other Rheostats in that its two resistance units—one low (6 ohms) and one high (40 ohms)—are connected in parallel (not in series) and the vernier adjustment is done on the high resistance while the current flows without interruption through the low resistance unit.

To grasp and understand this principle of the "MICROSTATS" Method of functioning is to concede its unsurpassed efficiency in adjusting and controlling, to the smallest quantity, the current flow through the filament of the tube—a great and important essential in selective tuning.

While accomplishing this prime and essential feature an absolutely quiet and noiseless adjustment automatically results for current flow is not—*nor never can be interrupted*—which sooner or later results in all Rheostats operating a Vernier in series with a low resistance Rheostat unit and which interruptions produce noises which defeat the true function of a Vernier for accurate selective tuning.

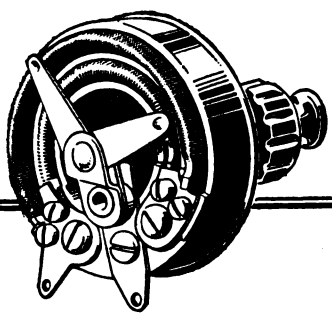
"MICROSTATS" EXCLUSIVE FEATURE

UNIVERSAL IN OPERATION—Controls any tube 1½ to 6 volts from 6 volt battery. STAYS PUT—Not affected by vibration. FULL ON—All Resistance cut out. RESISTANCE UNITS—Genuine "NICHROME" wire—6 ohms low—40 ohms high—connected in parallel—total safe carrying capacity, 3 amperes. MAIN BODY OR BASE—Bakelite Moulded. DIAL—Silver etched on black background. KNOBS—Moulded—Thermoplax. MOUNTING—one hole only in panel. NO MOUNTING SCREWS.

WRITE FOR BULLETIN NO. 92

Premier Electric Company

3807 Ravenswood Ave.
CHICAGO, U. S. A.

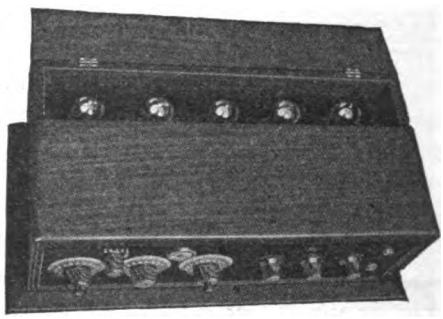


SERVICE ABOVE ALL

SERVICE RADIO CO.

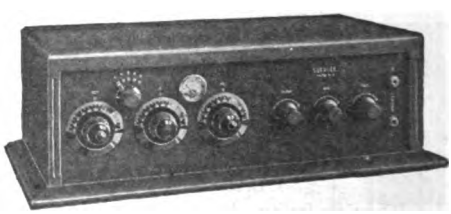
You Must See

this wonderful instrument to realize its beauty, its perfection in design and workmanship. You will have to listen to the beautiful programs which may be brought to your home by its use before you realize what "SERVICE" means.



SERVICE TYPE 212 Receiving Set with folding loop antenna, f.o.b. Cincinnati, O.

$150.00



Dealers, are you furnishing your customers with "SERVICE?"

WRITE FOR BOOKLETS

This is a TELEFORE product

SERVICE RADIO CO.

4729 Montgomery Road
CINCINNATI, OHIO

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Radio Catalogue Free—

Write us a post card—

Address Dept. 38-R

and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as $23.50.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

Headquarters for Radio

Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

Write to our house nearest you. Address Dept. 38-R

Chicago Kansas City St. Paul Portland, Ore. Ft. Worth

Montgomery Ward & Co.

The Oldest Mail Order House is Today the Most Progressive

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"Regal" Radio Products—Fit for a King

New "REGAL" Items for the 1923-1924 Season

New "Regal" No. 162
Double Arm Inductance Switch

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of hole. No more chipped panels. Complete with hard rubber Knob and Dial

$1.50

New "Regal" No. 200
Audio Frequency Amplifying Transformer

For clearness of tone, amplification of voice and music from nearby and distant broadcasting stations, is unequaled by any Transformer on the market

3½ to 1 Ratio..... **$4.50**
5 to 1 Ratio..... **4.75**

New "Regal" No. 120
Vernier Rheostat

For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market. Complete with Knob:

6-Ohms..... **$1.25**
30-Ohms..... **1.25**

If your dealer does not carry "REGAL" Products, write us direct

(Send for Catalog No. 24, showing 30 Big "REGAL" Items)

THE AMERICAN SPECIALTY COMPANY - Bridgeport, Conn.

The "Devouring Monster" of Radio

to most people has been the need of such large cash outlays at one time, and to many radio enthusiasts this has meant the purchase of lower priced, less satisfactory apparatus, or waiting for an interminable time to be able to secure the apparatus they wanted. This is no longer the case, as an

Attractive and Conservative

DEFERRED PAYMENT PLAN

for the purchase of "ANY piece of ANY make" of Radio Sets, Parts and Supplies, is now available to every responsible person. Write for full particulars, or better yet, send 25c. in stamps or coin and have the IODAR BULLETIN come to you each month. The IODAR BULLETIN contains a little of everything of interest to every radio enthusiast, as well as all the details of the IODAR PLAN, and is truly a catalog of opportunity.

Address Dept. 80

IODAR SALES COMPANY 114 S. Oak Park Ave., Oak Park, Illinois

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Send For This Handy Book Today

Contains Description and Illustrations of all Radio Parts

Explains Functioning of the Apparatus in the Different Circuits

This Pocket Size Edition Gives:

Variable Condenser Capacities—Variometer construction—Illustrations and description of radio symbols. ¶Why rheostats should have greater contact surface. ¶Advantages of light weight receivers. ¶Why Bakelite is the best insulation for radio. ¶New and ingenious inductance switch and knob—Defines radio terms—Explains importance of good aerial and ground. ¶But—most of all—It shows the beginner, why the highest class apparatus is the most economical and satisfactory—54 pages of interesting information and illustrations.

THIS BOOK IS FREE

Write for it today. Address Radio Dept. H.

KELLOGG SWITCHBOARD & SUPPLY COMPANY
1066 West Adams Street, Chicago, Illinois
Columbus, Ohio Kansas City, Mo. Portland, Ore. San Francisco, Cal.

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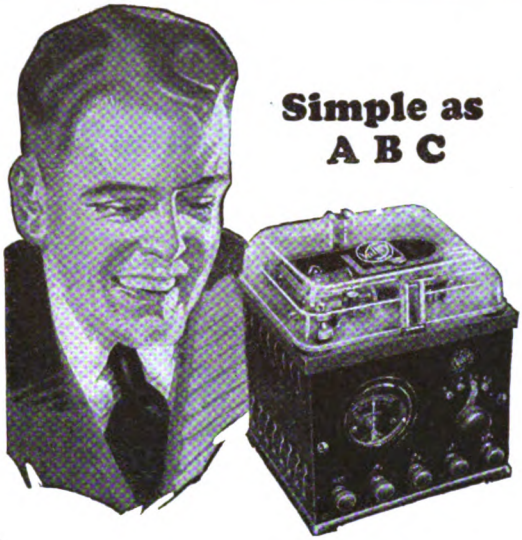


Simple as A B C

—And comprehensive, too. The new Valley Battery Charger, Type ABC, charges all Radio storage batteries—2-volt peanut tube batteries, 6-volt A Batteries, and 1 to 4 B Batteries. Also charges 12-volt batteries.

Plugs into regular electric light socket. Uses a negligible amount of current—a dime's worth for an average charge.

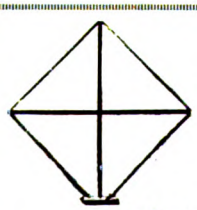
Unfortunately, production is limited. Don't miss out, and don't buy another until you have seen the Valley Type ABC Charger. At all good radio dealers.

VALLEY ELECTRIC CO.
3157 S. Kingshighway · St. Louis, Mo.

Valley Battery Charger

ROCKY MOUNTAIN RADIO PRODUCTS

CRYSTALS Any Style of Radio Material at Lowest Prices!



NEW K-D SPRING LOOP AERIAL

LIST PRICE $1.00

Distributors Bus, Aerial, Magnet **WIRE**

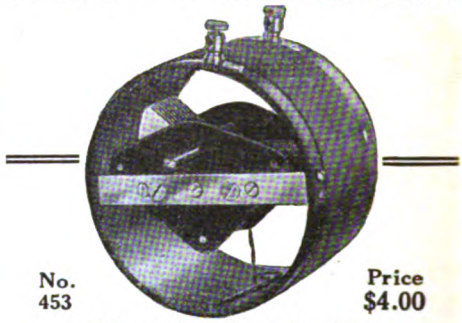
Write for Discounts

Rocky Mountain Products Co.
9-B Church St., New York

VERNI-TUNER
(Trade Mark)

3 in 1 *Primary, Secondary and Variable Condenser*

NO TAPS - - NO INTERFERENCE



No. 453 Price $4.00

"Razor Like"—Selectivity

Enthusiastically acclaimed by Radio Amateurs.

SAVES LABOR—SPACE—MONEY

Main tuning device for all Reflex circuits, all Standard Regenerative Circuits, Tuned Radio Frequency Circuits and the Horne Combined Reflex and Tuned Radio Frequency.

Other units for Reinartz, Cockaday, Flewelling and other circuits.

Booklet of 14 circuits free with each device.

At your dealer or postpaid on receipt of purchase price. Write for leaflet.

HORNE ELECTRIC & MFG. CO.
Mercer & Colgate Sts. Jersey City, N. J.

Six Questions and The Answer

Do you have difficulty obtaining and maintaining a FINE adjustment with your radio set?

Do you want to make your set 100% MORE selective?

Do you want to hear stations that you believed your set would never bring in?

Do you want to eliminate some of the body capacity with which you have been troubled?

Do you want to add fine vernier adjustment to a plain condenser that will be more efficient than the so-called vernier condenser and at much less cost?

Do you want to improve the appearance of your set?

If your answer is "Yes," then

USE THE UNIVERNIER

The Univernier is a knob and silver plated 360° scale with a self-contained mechanism which reduces motion of the shaft to the knob 12 to 1. Slight pressure on the knob will cause the device to function as an ordinary knob.

As easily installed as the ordinary knob. Makes variocouplers, variable condensers, variometers, tickler coils, variable radio frequency transformers, potentiometers, and rheostats all vernier in action. Eliminates trouble from unbalanced instruments. A necessity on neutrodyne hook-ups. Makes all adjustments constant.

The use of the Univernier is the only logical and fundamentally correct method for obtaining vernier adjustment of radio apparatus.

List Price $1.25

Made in two sizes:

No. 251 for ¼" shafts — Diameter of knob 2¼"
No. 188 for 3-16" shafts — Diameter of scale 3¼"

At your dealers or post-paid upon receipt of the above amount.

Walbert Manufacturing Company
933 Wrightwood Ave. Chicago, Ill.
Dealers and Jobbers write for Discounts

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An Authority Describes The Ideal Radio Receiver

"It seems to us," says the Editor of Radio Broadcast, "that a set having radio and audio frequency amplification, without regeneration, must be possible in such a design that the only adjustment required is the one dial tuning the antenna circuit—the antenna being a loop . . . . To do away with the tinkering—simply to turn one handle to a definite marked point and get the station wanted . . . . that is the kind of a set which will find favor in the future."

Yes, Mr. Editor, you are right. Such a set is already finding favor all over the United States. It is the De Forest D-7-A Reflex Radiophone, and the D-10 Four-Tube Reflex fills the same prescription, with the addition of a Vernier Variable Condenser for precision tuning.

DE FOREST RADIO TEL. & TEL. CO.
Dept. P. R. 3 Jersey City, N. J.

If located west of Pennsylvania, address
DE FOREST RADIO TEL. & TEL. CO.
WESTERN SALES DIVISION
Dept. P. R. 3, 5680-12th St. Detroit, Mich.

RADIO CATALOGS **FREE** *Send us your name and address and we will send you the De Forest catalog and price list of sets, audions and parts.*

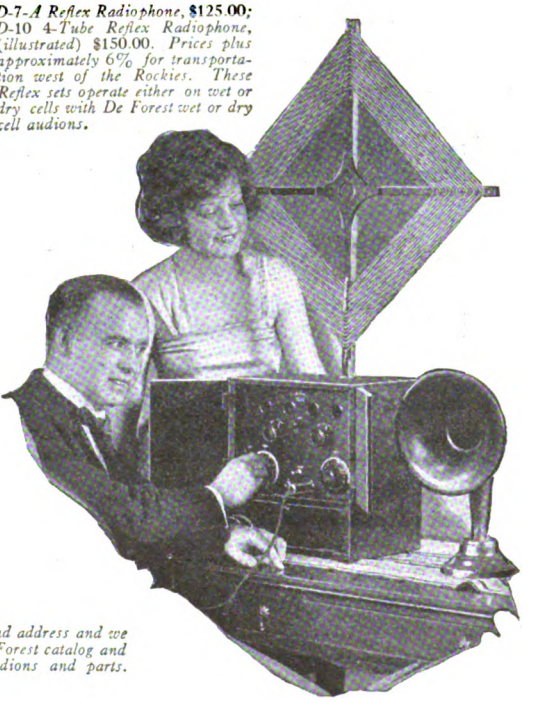
In spite of new fangled circuits, the De Forest Reflexes are snatched up by the radio public faster than we can make them, because of their *simplicity* of installation and operation—the fact that they cost so little to operate—the elimination of the outdoor aerial—and their great selectivity. You can get the station you want, when you want it, without interference.

These features, with a range on indoor loop of from 1,500 to 3,000 miles according to atmospheric conditions, have made people prefer De Forest Reflexes at $125.00 and $150.00 to sets costing four times as much.

Whether you buy complete sets or build your own—

"Rely on De Forest, the Greatest Name in Radio."

D-7-A Reflex Radiophone, $125.00; D-10 4-Tube Reflex Radiophone, (illustrated) $150.00. Prices plus approximately 6% for transportation west of the Rockies. These Reflex sets operate either on wet or dry cells with De Forest wet or dry cell audions.



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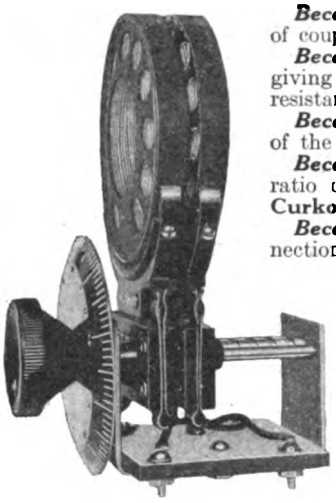
CURKOIDS FOR RADIO FREQUENCY

The Curkoid Adjustable Radio Frequency Unit
is the solution of the Radio Frequency Problem



Because it is the only unit on the market which permits of adjustment of coupling between primary and secondary.

Because it is the only unit which employs **Curkoid** inductances, giving highest inductive value for minimum distributive capacity and resistance.

Because it is adapted to any band of wavelengths by the selection of the correct combination of interchangeable **Curkoid Inductances.**

Because it is adapted for use with any make of vacuum tube for any ratio of transformation which can be obtained with interchangeable **Curkoid Inductances.**

Because it is readily used in tuned radio frequency circuits in connection with efficient variable condensers.

Curkoid Inductances are wound in the form of a curtate eptrochoid, giving the highest value of inductance for a minimum distributive capacity and resistance. Adjacent turns are separated by the greatest distance possible without sacrifice of efficient magnetic field distribution.

The Curkoid Adjustable Radio Frequency Unit is designed for use with or without a tuning condenser. Micrometer coupling adjustment moves the coil but 1-400 of an inch per turn of the control knob.

The Curkoid Two Coil Coupler and The Curkoid Three Coil Coupler make possible the use of any circuit.

Booklet giving hook-ups and structural data for tuned and untuned radio frequency circuits, neutrodyne, regenerative, super-regenerative and Reinartz circuits will be mailed to you upon receipt of ten cents.

Curkoid Adjustable Tuned Radio Frequency Coupler $2.75, without Variable Condenser

RIEGER RESEARCH CORPORATION

114 West 44th Street - - - New York City

SPECIAL OFFER

Two **new yearly subscriptions to POPULAR RADIO for only .... $3.**

Rope this Special Offer! It means a big saving to you. You and a friend of yours may have POPULAR RADIO for a whole year, provided you are both NEW subscribers. Just throw a check for $3 around the double coupon and MAIL IT TO-DAY before the price goes up to $3 for only *one* year's subscription!

(Coupon good only until December 15th, 1923)

POPULAR RADIO, Dept. 114,
9 East 40th Street, New York City.
Please send POPULAR RADIO for one year to:

NAME.....

ADDRESS.....

CITY.....STATE.....

And also to this other new subscriber. Here's my cash remittance—(or a check or money order for $3).

NAME.....

ADDRESS.....

CITY.....STATE.....

(No extra for Canada. Foreign countries 25 cents extra per subscription.)

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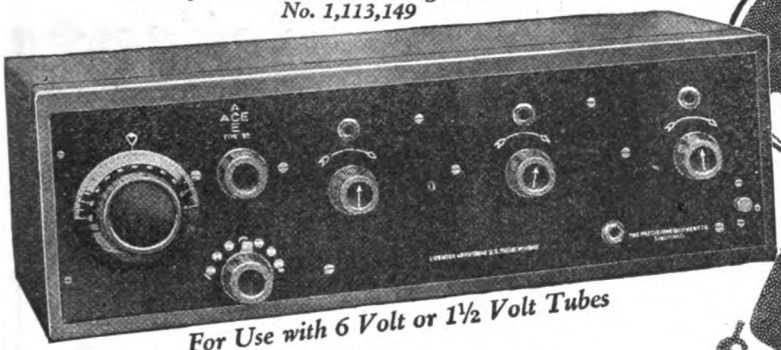
THE NEW ACE

Three Tube Regenerative Receiver

Manufactured under Armstrong U. S. Patent No. 1,113,149



For Use with 6 Volt or 1½ Volt Tubes

3B

ONLY

$50.00

If your dealer cannot supply you, order direct, mentioning his name. Ask for "Simplicity of Radio." Your copy is FREE.

DEALERS:

Write on your letterhead for attractive sales proposition.

This New Ace Type 3B Armstrong Regenerative Radio Receiver combines detector and two stages of Audio frequency amplification. The lowest priced quality receiver ever offered.

When you tune in with this set distant stations come in as though they were only a few miles off. The two stages make the use of a loud speaker possible—this is a desirable feature. Its efficiency has passed every test.

One of the few sets that functions perfectly with all makes of tubes. Has filament switch which eliminates necessity of turning out the rheostats when set is not in use. With this switch you can turn off set and come back later to same concert without retuning. The telephone jack makes it possible to use head phones. When head phone plug is inserted it automatically eliminates loud speaker, but does not affect the filament current. Has genuine mahogany cabinet with beautifully engraved panel.

The Ace Type V

Formerly Called Crosley Model V

The low cost of this set together with its efficiency and simplicity makes the great demand for it increase daily.

$20

A long range receiver. Stations from coast to coast can be heard distinctly. An Ace Two-step Amplifier in connection with this set at $20 makes use of loud speaker practical. Has Crosley Multistat, which permits use of any make tube.

THE PRECISION EQUIPMENT COMPANY

Powel Crosley Jr. PRES.

1116 Vandalia Ave. Cincinnati, Ohio

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DESIGNED ESPECIALLY FOR RADIO RECEIVING

We are Manufacturers of Fine Furniture and we sell direct to you with only a small factory profit.

A handsome hardwood hand-rubbed mahogany or golden oak finished Radio Table. Size of top 20 x 34 inches x 31 inches high.

Conceals A & B batteries. Small drawer holds tools and accessories.

PRICE, FREIGHT PAID, East of Mississippi River.....**$18.00**
FREIGHT PAID to Rocky Mt. States..**20.00**
FREIGHT PAID to Pacific States.....**22.50**

Cash with order. Prompt shipment.

CABINET PRICES REDUCED!

Hardwood, hand-rubbed mahogany finish. Hinged top.

Panel Size	Depth	Price
6 x 7 in.	7 in.	**$2.25**
6 x 10½ in.	7 in.	**2.50**
6 x 14 in.	7 in.	**3.00**
6 x 21 in.	10 in.	**3.75**
7 x 18 in.	10 in.	**3.50**
9 x 14 in.	10 in.	**3.50**
12 x 14 in.	10 in.	**4.00**

POSTPAID, East of Mississippi River.

POSTPAID to Rocky Mt. states, add 25 cents.

POSTPAID to Pacific states, add 50 cents.

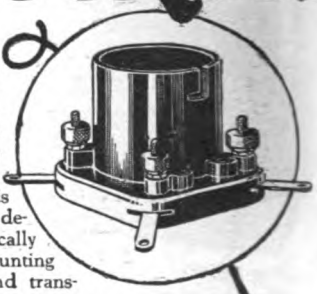
Cash with order. Prompt shipment.

Send for free catalogue of Radio Furniture.

THE SOUTHERN TOY CO.
HICKORY, NORTH CAROLINA

Announcing

E. T. Flewelling Sockets



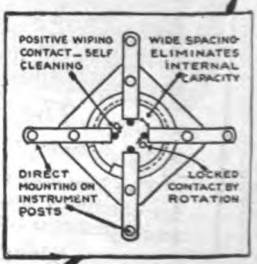
The first unit of a series of parts designed by Mr. E. T. Flewelling, inventor of the 'Flivver Circuit,' which will assemble into a really capable set is the Flewelling Socket. This socket has terminals so designed that they practically assemble the set by mounting on tuner, rheostat and transformers direct.

Internal capacity has been whipped by so spacing a new type of contact terminal that ideal conditions for radio frequency and reflex work are established. Further—good, clean contact against the base part of the tube terminals, with an easily inserted and firmly held tube, results in eliminating doubt as to good electrical contacts.

E. T. Flewelling says:

"Stray or internal capacity effects must be eliminated if we are to secure maximum results."

Watch this space in our advertisements for a series of helpful hints that will enable the radio fan to build a better set than has heretofore been deemed possible.


POSITIVE WIPING CONTACT—SELF CLEANING
WIDE SPACING ELIMINATES INTERNAL CAPACITY
DIRECT MOUNTING ON INSTRUMENT POSTS
LOCKED CONTACT BY ROTATION

PRICE

Standard tube Socket **$1.00.** At your dealers or, until he is supplied, post paid upon receipt of price.

BUELL MANUFACTURING COMPANY
2979 Cottage Grove Avenue
CHICAGO

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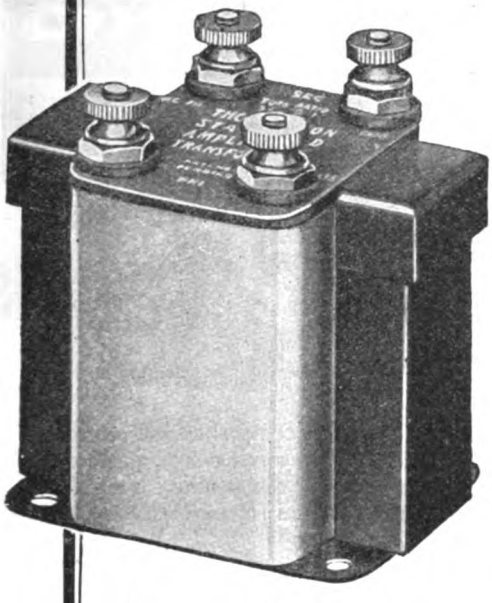

The New

THORDARSON

Super Transformer

More than a quarter of a century has been devoted by Thordarson engineers to the design and development of power transformers ranging in size from the smallest bell ringer to the first 1,000,000 volt transformer the world ever saw.

That knowledge and practical experience has been intelligently devoted to devising an Audio Frequency Amplifying Transformer that would produce the greatest volume consistent with *true tone quality*.

Here it is—its specifications and efficiency under all atmospheric conditions and over all audible signals, ranging from 100 to 7,000 cycles have been tested and endorsed by the foremost radio engineers in the United States. Thousands of these new amplifying transformers are daily furnishing the means to greater pleasure and entertainment to discriminating radio amateurs and experimentors.

Developed and manufactured entirely by Thordarson engineers in the Thordarson plant

It is not merely an assembly of bought coils, core iron, etc., as is the case of most audio frequency transformers in the market.

Core is made of .007 highest grade silicon steel, No. 36 gauge, the cross section of which measures ¾ inch—twice that of the usual type transformer. Coil is *square layer wound* of No. 40 wire to fit the square core. The winding process and machinery were designed and developed exclusively by Thordarson.

The basic principle and construction of this new Thordarson product are scientifically, electrically, and mechanically correct. Exhaustive tests and experiments have proved conclusively that:

1. Core losses are reduced to a minimum.
2. Over-saturation of the core is eliminated.
3. When in use the resistance of the plate circuit of one tube and the resistance of the grid circuit in the following tube are balanced to a degree heretofore unequaled.
4. The received energy is increased sufficiently to actuate loud speaking devices without distorting the incoming signal.
5. The volume produced is as great as ***pure tone*** *quality reproduction will permit.*

The new Thordarson amplifyer is the choice not only of thousands of amateurs and experimenters, but an increasing number of leading receiving set manufacturers now specify Thordarson Transformers as standard equipment.

Make your own test

Words nor pictures nor specifications alone can do justice nor prove the superiority of Thordarson products. Let your own ears guide you in your comparison.

SOLD AT ALL GOOD DEALERS

PRICE, MOUNTED ONLY

6 to 1 ratio transformer . $4.50
(with Red Label)

3½ to 1 ratio transformer 4.00
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ELECTRIC MFG. CO.

Huron and Kingsbury Streets, Chicago

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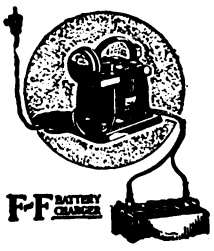
The Ideal Gift



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Type 6 charges 6 Volt storage battery from any 110 Volt 60 Cycle lamp socket at average rate of 6 amperes, or over if battery needs it.

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The F-F, the first successful mechanical charger, is now the most popular. F-F features are distinctive, its construction is simple, and the absence of breakable parts which are expensive to replace, is almost sufficient reason for you to own the F-F; but the satisfaction you will buy with the low purchase price of the F-F is further reason why you should insist on the F-F.

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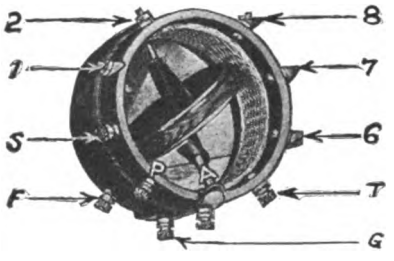

F to S—Main Inductance
A to G—Vernier Rotor
T to P—Untuned Primary
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in our No. 2 Hook-up is giving thousands of users better range, control, selectivity, and dependability than they ever before experienced.

For diversion, they try out others among the good tested circuits for which we supply photo-diagrams.

Our slogan has always been "More than you expect," and in the language of the highest grade firms throughout the radio world, our products "are in a class by themselves."

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AUDIO-FREQUENCY TRANSFORMERS

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Powerful Amplification

Clear and Perfect Reproduction on All Wave Lengths

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Designed to Meet the Characteristics of All Tubes

The Highest Grade Amplifying Transformer Manufactured

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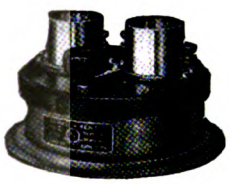
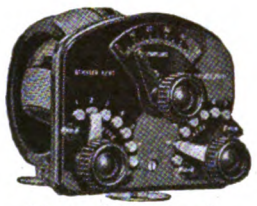
ATWATER KENT
RADIO EQUIPMENT

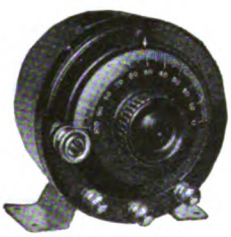


2-Stage Amplifier

Type 11 Tuner



Mounted Variocoupler



Variable Condenser Table Mounting, Front Control

ATWATER KENT Radio equipment is distinctive for the quality of its performance. Parts and Sets embrace a variety sufficiently wide to meet the requirements of every user of radio.

Sets commence with the simplest combination of tuner and detector unit and include the most complete arrangement of units that has been found practical.

Parts include every instrument necessary to the assembling of complete sets.

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Every ATWATER KENT Radio Product represents the accumulated experience of more than 25 years in the design and manufacture of scientific electrical equipment.

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STARTING AND LIGHTING

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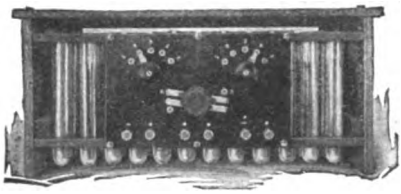

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Cells	Volts	Price, plain	With panels
16	22	$5.50	
24	32	7.25	$11.75
36	48	9.50	14.00
50	68	12.50	17.00
78	100	17.50	22.50
108	145	23.50	28.50

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GUARANTEE

Your money back on any KICO Battery if not satisfied within 30 days' trial. Write for full information on "A" and "B" Batteries.

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We are the exclusive distributor of the Mu-Rad Receiver in the states of Illinois, Indiana and southern Wisconsin. If your store is in any one of these three states, Mr. Dealer, write us today for details of our special exclusive territory proposition. Winter's here—there's need for haste!

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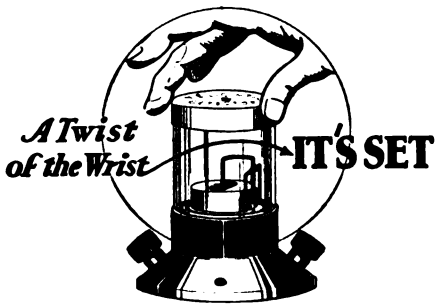

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CRYSTAL DETECTOR

The every-purpose detector—fixed or changeable adjustment, just as you desire. Tune with the YELLOWTIP. No hunting or looking for a sensitive set—just "A Twist of the Wrist—It's Set". Micrometer adjustment in a moment, fixed indefinitely. Ideal for reflex and other circuits. **$2**

Write for folder and name of your nearest dealer.

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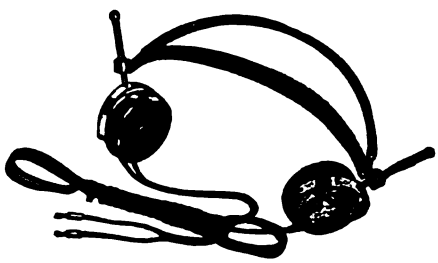

2200 Ohms—$6.00

OUR MOTTO IS *QUALITY NOT QUANTITY*

Every precaution is used in buying materials, in assemblying parts and testing phones, assuring the purchaser of a perfect, comfortable and durable phone with a loud, clear and equalized tone.

Every phone guaranteed.

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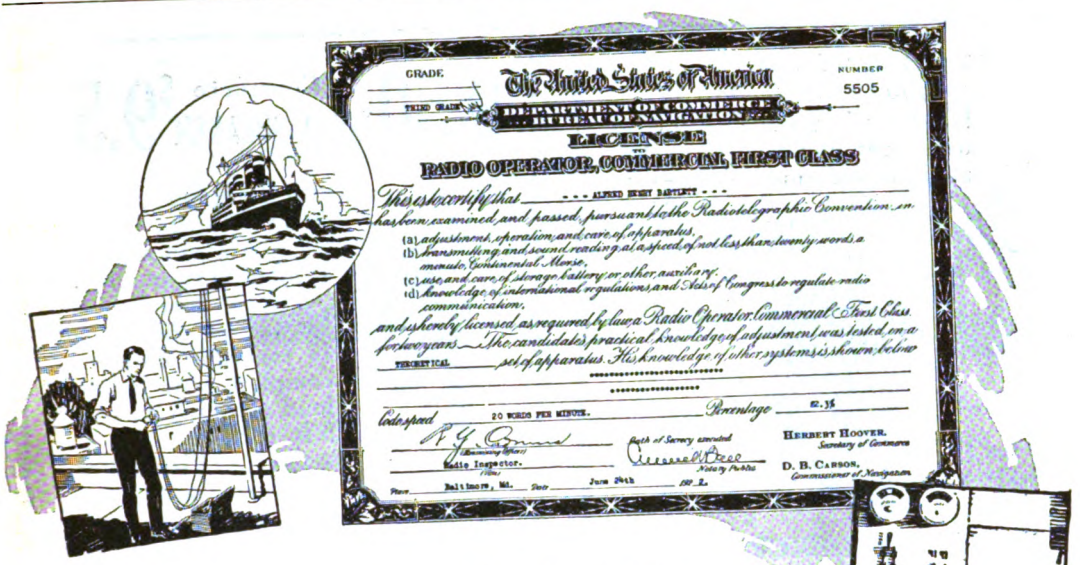
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(a) adjustment, operation and care of apparatus,
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for two years. The candidate's practical knowledge of adjustment was tested on a
THEORETICAL set of apparatus. His knowledge of other systems is shown below
Code speed 20 WORDS PER MINUTE. Percentage 92.3%
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Seal of Secretary executive
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Commissioner of Navigation
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Get This First Class Radio License

You Can Earn Big Money With It

THE best paid positions in radio go to the men who hold the Government's First-Class Commerical License. The radio men on every ship, in every land commercial station, in every broadcasting station, must have one of these licenses. Every radio inspector must pass the first-class license examinations. Engineers, mechanics, installation and maintenance experts must all of them own a Government First-Class Commercial License in order to operate a transmitting station. It is every radio man's ambition to get a license, not only because it is the highest mark of honor he can get but because it also opens to him all the wonderful opportunities in this great profession.

Emmett Welch of Peculiar, Mo., is Radio Salesman making $300 per month and expenses, Merle M. Wetzel is inspector in the Engineering Dept. of a Public Service Co., Edwin Forsyth is on his way to Scotland as first-class licensed operator on board ship. Read in the panel of the fine salaries paid in all the wonderful positions open to you as soon as you get the Government First-Class License.

Pick Out the Job You Want and We Will Help You Get It

We have trained hundreds and helped them to splendid paying positions in Radio. You will be interested in knowing exactly what these graduates are doing and in reading the actual letters written by them. Our new Free Book contains scores of these letters, each one a story of success in itself. Send for this book.

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Radio Mechanic, $1,500 to $4,000 a year.
Radio Inspector, $1,800 to $4,500 a year.
Radio Salesman, $2,000 to $10,000 a year.
Radio Engineer, $3,500 a year and up.
Radio Executive, up to $15,000 a year.
Radio Instructor, $200 to $500 a month.
Radio Draftsman, $7 to $15 a day.
First Class Snip Operator, $120 a month, all expenses paid.
Commercial Land Station Operator, $150 a month and up.
Broadcasting Station Operator, $125 to $250 a month.

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The National Radio Institute, America's first and largest Radio School, has devised a remarkable new method that makes it easy for you to win your license. No previous experience in electricity or radio is necessary. Spare time study at home prepares you in an amazingly short time to pass the Government examinations, so you can get one of the fine jobs waiting in this great field. The diploma we give you upon completion of the course, counts for 5 to 10 credits on all government license examinations.

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An extraordinary feature of this course is the use of four patented instruments, owned exclusively by us, which give practical training in radio operation, installation and maintenance and repair—all of which you **must** have to become an expert.

Among these instruments is the wonderful Natrometer, said by experts to be the perfect device for teaching the Radio Code. All of these instruments are given free during the course.

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"Where ignorance is bliss
'tis folly to be wise"

but that is no excuse for not using the acknowledged best audio transformer—

The AMERTRAN
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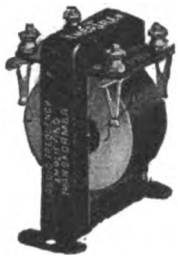

Price $7
Ask your dealer.

Or, sent carriage charges collect. (Wt. 1 lb.)

STANDARD of EXCELLENCE

Turn ratio, 5:1. Amplification ratio, 30-40 times audibility in the flat part of the curve.

Send for Circular 1005

American Transformer Company
Designers and builders of radio transformers for over 22 years.
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$9.50 A Complete LOUD SPEAKER $9.50

A Loud Speaker for thousands of Radio Fans who are looking for a moderate priced speaker with quality.

Heavy metal horn, 21 inches high, bell 11 inches in diameter, complete with special loud speaking unit and 5 ft. cord.

Colors: Plain Black or Brown Satin finish; also special Alligator grain in Black and Green or Black and Yellow.

Price of horn only with phone adapter, without loud speaking unit, $5.50

Liberal Trade Discounts

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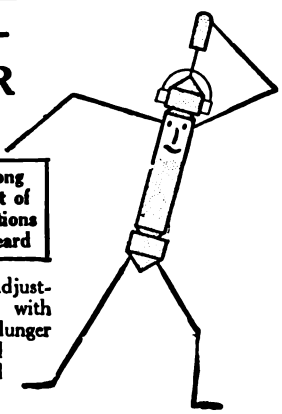
DURHAM + DUBILIER
Tube Control

Equal the other fellow's

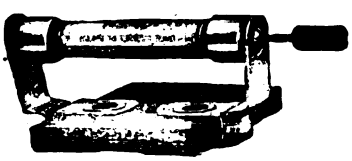
Long list of stations heard



Distance depends on fine adjustment — the kind so easy with DURHAM one-finger plunger resistance control. Mounted on famous Micadon grid condensers.

DURHAM Variables
No. 101—0.1 to 5 megs.
No. 201A—2 to 10 megs.

DUBILIER Condensers
.00025 mfd.
.00050 mfd.



Guaranteed Satisfaction

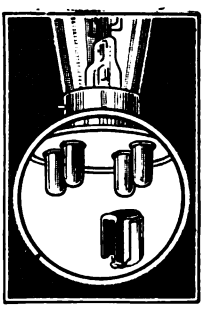
Your dealer has it for $1.10 complete

Durham & Co., 1936 Market St., Philadelphia

Dealers:—Other stores in your town list DURHAM-DUBILIER—*on their cash register!* How about you?

GAMBLING?

YOU ARE IF YOUR RADIO TUBES ARE UNPROTECTED



Your Vacuum Tubes are the most delicate parts of your Radio Set.

They are easily blown out—you have probably already had this exasperating experience—it is apt to happen at any time.

"B" Battery wires accidentally crossed for only an instant with the filament leads or sudden excess current from the "A" Battery will do it.

You can prevent this and save yourself money and inconvenience and relieve your mind at a trifling cost.

INSTALL
RADECO SAFETY FUSES

on all your tubes. Applied in an instant to one of the filament terminals. Will fit any standard tube going in any standard socket.

Price 50 cents each, sent postpaid and fully guaranteed. Do not delay. Order now. Specify type of tube used.

DEPT. 2
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Manufacturers and Distributors of Standard Radio Equipment
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New England's Oldest Exclusive Radio House
Dealers:—Write for our proposition

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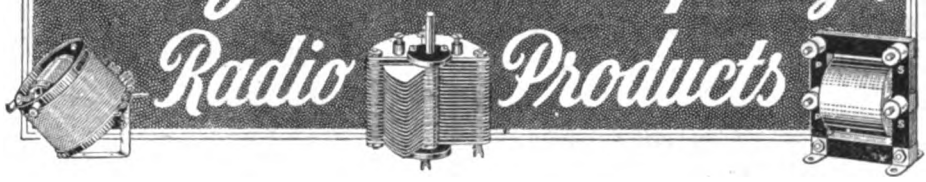
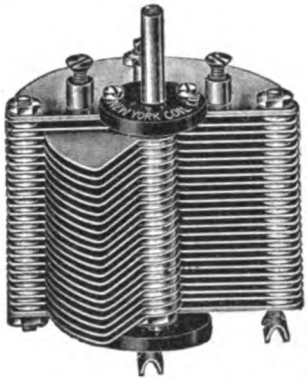
New York Coil Company's Radio Products



Are leaders everywhere due to quality, ease of installing and assurance that your set will bring in the results when finished. Used by leading constructors and handled by the best informed dealers.

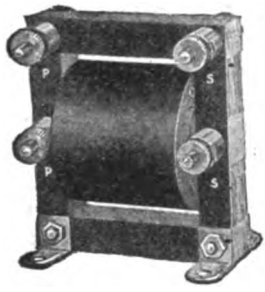


New York Condensers bring in the broadcasting loud, and clear with the true tone, because the construction eliminates **all leakage** and **electrical losses**—the standard by which others are judged.

11	Plate	**$1.50**
23	"	**2.00**
43	"	**3.00**
3	"	**1.25**

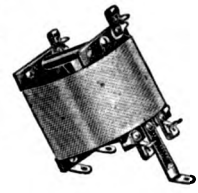
Supplementary Vernier Condenser $1.00

Insist on New York Amplifying Transformers. Do not be satisfied with something claimed to be "just as good." They are universally recognized for their marvelous **amplification,** purity of tone and ability to produce uniformly perfect results with any style of standard tube. Price $4.00 and worth it.



Our skeleton type tuned Radio Frequency Transformers really give the D X results with loop or indoor aerial that you have long wished for. Totally unlike any other in design or results. Two required, fully guaranteed.

$4.00 Each



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SCHINDLER'S

BUILD-UP

50c to 75c

MICA CONDENSER

Schindler's "Build-Up" Condensers fill a definite need for reasonably priced condensers that may be easily increased or decreased in capacity.

By the use of a "Build-Up" Mica Condenser you can change from an ordinary phone condenser to a special .006 value used in the Flewelling Circuit.

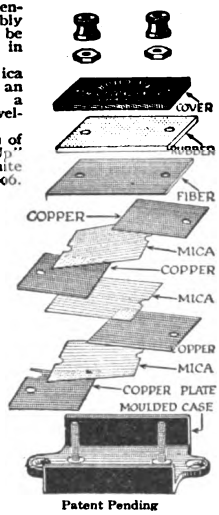
By simply adding extra plates of mica and copper to the "Build-Up" base, you can obtain any definite capacity from .00025 to .006. (Each mica plate with the alternate copper plate has a capacity of about .002 Mfd.)

"Build-Up" Condensers are dilation proof. They insure high efficiency and will add satisfaction to the operation of any set. Each assembled complete in neat carton. Prices:

Mfd.	List Price	Mfd.	List Price
.00025	50c	.0025	65c
.0005	50c	.00E	70c
.001	55c	.006	75c
.002	60c		

Extra envelope containing 20 mica and 20 copper plates, or sufficient to build up a condenser from .00025 to .006 list price 25c. Table showing required number of plates for any capacity is furnished with each condenser.

Ask your dealer or order direct.



Patent Pending

CHARLES SCHINDLER
1403 West Delaware Avenue
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Free Your Set From INTERFERENCE

WARREN RADIO LOOP

The U. S. Army Signal Corps use loops to obtain absolutely unlimited, uninterrupted radio communication. To really enjoy your super-sensitive set, banish interference from static, stray atmospherics by using a loop aerial, the best you can buy—a **Warren Radio Loop.** More "persistent" than the dangerous, cumbersome old-fashioned outside aerial. Easier to tune. Built on stronger frame and protected from dust, dampness and meddling by tight cover. Types for all wave meter lengths from 175 to 18,000. Most compact, efficient loop perfected. Buy a **Warren Radio Loop** Now!

Type A-737 (300-700 meters) 6 inches square—non-directional.....**$10**
Type A-7236 (175-1000 meters) 6 inches square—non-directional.....**$12**
Type B-2537 (300-700 meters) 18 inches square—directional.....**$20**
Type BL-2520 (200-18,000 meters) with honeycomb coil mounting. 18 inches square—directional.....**$25**

Send for Bulletin 1-102

V-DE-CO RADIO MFG. CO., Dept. F. Asbury Park, N. J.

BDXX **Durable!**

BDXX panels are PERMANENT. Their service is unending. Once installed, they satisfy for all time. Never has it been necessary to replace one.

bakelite-dilecto!!

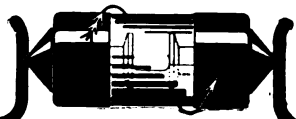
(*A Laminated Phenolic Condensation Material*)

Highest in dielectric strength. Surprisingly hard and tough; yet readily machined. Proof against water, heat, fumes, solvents and milder acids.

Ozone from high-voltage electrical apparatus, which quickly ruins hard rubber, has absolutely no effect on Bakelite-Dilecto.

XX grade Bakelite-Dilecto has every radio-advantage. Insist on it at any electrical store.

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware
Dealer Service From:
New York, 233 Broadway
Pittsburgh, 301 Fifth Ave.
Chicago, 332 S. Michigan Ave.
San Francisco, 75 Fremont St.
Los Angeles, 411 S. Main St.
Seattle, 1041 Sixth Ave., S.



PAT. APP'D FOR

75c TURN-IT 75c

GRID-LEAK *"ADJUSTABLE"*

YOUR SET DESERVES ONE!

EVERYBODY has fussed with grid leaks to find the one best suited for his tubes and circuit and has discovered many of the variable carbon leaks would not hold their adjustment.

BUT when you clip a TURN-IT in your standard mounting you can be sure your grid-leak problem is solved.

THE high resistance liquid with its smooth flowing, velvety contact instantly gives you the value required and there it stays until you turn it to another value.

Your dealer should have one, if not send 75c to

Charles E. Bonine
20 South 15th St. Philadelphia

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Tells how to get those stations you read about but never hear

BALLANTINE
VARIOTRANSFORMER
for
Radio Frequency
Amplification
(Patents Pending)

On Sale at All Good Radio Stores
or Postpaid, Price $9.60

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"Radio Frequency Amplification with the Ballantine Variotransformer"

Here's a booklet that will help you get many stations that you've never heard before. Based on research of the Radio Frequency Laboratories, Inc., it gives the latest developments in tuned radio frequency amplification. Furthermore, it tells how to use the *continuously variable* BALLANTINE TRANSFORMER for both amateur and broadcast wavelengths—with amplification *uniformly high.*

Free for the asking, this 25-page booklet is full of facts, helpful information and practical diagrams. Edition is limited—better write for your copy at once.

BOONTON RUBBER MFG. CO.
224 Fanny Road
Boonton, N. J., U.S.A.

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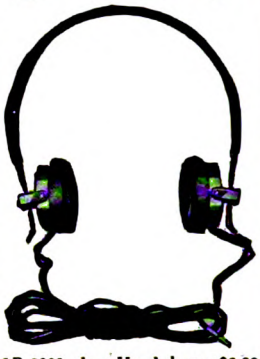
TO the manufacturer of one or more articles of meritorious radio equipment, this organization, well experienced in the trade of Spanish and Portuguese speaking countries, offers a service of exceptional interest.

We now handle the export business of Dubilier Products, Burgess Batteries, Rasla Products and Freed-Eisemann and are equipped to take on one or two additional high grade lines. Full information and statistics on market conditions in these countries will be given confidentially on request.

AD. AURIEMA
116 BROAD STREET
NEW YORK CITY

$6.00 Headphones of Sterling Quality

Telephone Instrument Manufacturers of long experience now offer radio buyers, Headphones that have been brought to a high state of efficiency by successful manufacturing of voice transmission equipment. Leich Radio Headphones with Eureka Headband are light weight, comfortable, and durable. Bakelite caps and metal containing cups guard the accurate adjustment necessary to maintain a sensitive instrument.



1B-2000 ohm Headphone $6.00

An ideal combination is the Leich Headphone with No. 60 L'-Radio Plug attached.

60 L'-Radio Plug $.90

Order direct or thru dealer or jobber.
Radio Booklet 101G lists the additional accessories.

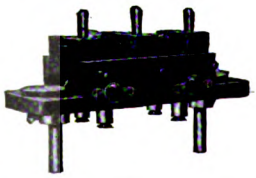
LEICH ELECTRIC CO.
GENOA, ILL.

STA-PUT JR.

The latest arrival in the best line of radio plugs in the world. Lightning adjustment without tools. Extra small size and fine polished finish.

List price fifty cents

MARTIN-COPELAND COMPANY
Providence, R. I., U. S. A.



INSIDE COIL MOUNTINGS

Coils are **inside** the cabinet where they belong.

The movable coil is operated from a dial on the panel, giving vernier adjustment and eliminating body capacity.

Pigtail connections. Adjustable tension springs.

Made in double and triple sizes.

No. 2A Mountings..... $3.75
No. 3A " 5.00

Use "Honeycomb" or "Spiderweb" inductance for best results.

WIRELESS ELECTRIC CO.
204 Stanwix St. Pittsburgh, Pa.

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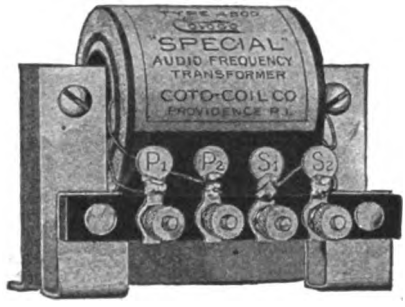
Coto

"Built First to Last"

You Double the Real Fascination of Radio—

when by your own ingenuity and effort, you equal and very likely surpass the best results obtained by ready made radio sets.

Build your own, your personal set. Know the joy of conquering the infinite. And build it right. Coto for compactness, portability and reliability.



Coto Special Audio Frequency Transformer

A triumph of manufacturing economy. Designed to sell at a price but superior in material, in workmanship and in performance. Absolute dependability, as your dealer will assure you. Turn ratio 3 to 1. Excellent volume of amplification. Type 4500..... **$2.50**

Jobbers! Dealers!

The Coto line of superior radio apparatus is already on its way to tremendous selling. You deserve a share of this business. Write for folder and price lists.

Coto Coil Co.

87 Willard Avenue

Providence, Rhode Island

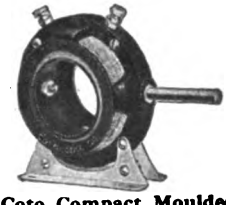
Pacific Coast Branch,
329 Union League Bldg.,
Los Angeles, Cal.

Northwestern Branch,
Geo. F. Darling,
705 Plymouth Bldg.,
Minneapolis, Minn.

Southeastern Branch,
C. P. Atkinson,
Atlanta Trust Co. Bldg.,
Atlanta, Ga.

Cotogrip Tube Socket
Has unique double positive grip of tube terminal posts. Best hard rubber insulation. Type 7000..... **85c**

The Original Honeycomb Wound Coils
Popular low priced favorites of the amateur and experimenter. Descendants of the Coto Coils that guided the N. C. navy planes across the Atlantic. Sold mounted or unmounted.



Coto Compact Moulded Variometer
A little gem in moulded bakelite. Stator is honeycomb wound. Range 200 to 600 meters. Size 3½ x 1¾ x 3¾ inches. Base or panel mount. Type 8000..... **$5.00**

Coto Tapped Radio Frequency Transformer
Efficiently covers the whole broadcasting range because it is TAPPED. Just turn the switch. Type 5000 **$7.50**

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For Better Receiving

Elgin Precision Condensers

Accuracy in your condensers means better results in your receiving. Elgin Precision Condensers are accurate. Permanent accuracy and rigidity are built into them.

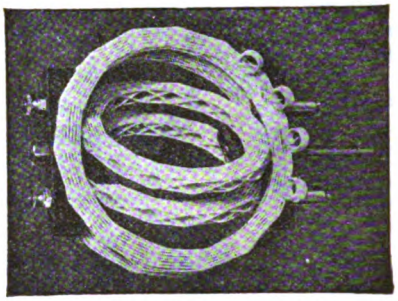
Fully Guaranteed

Size	Capacity	Plain	Vernier
3 Plate	.000063 M. F.	$1.75	$——
11 Plate	.00025 M. F.	2.40	4.00
17 Plate	.00035 M. F.	2.75	——
23 Plate	.0005 M. F.	3.00	4.50
43 Plate	.001 M. F.	4.00	5.50

3″ diameter composition dials, 50c extra

See your local dealer. If he cannot supply you send his name with your order to

The Elgin Tool Works, Inc.
69 N. State St., Elgin, Illinois



R. M. C. Diamond Weave Variocoupler and Variometer

Due to diamond weave construction and the fact that ⅞ of the total area of windings are supported in mid-air, capacity and dielectric losses are reduced to a minimum in R. M. C. Variometers and Variocouplers. The rotor is continuously variable.

These products may be used in any circuit where a high grade coupler or variometer is required.

All metal parts are nickel-plated. Panel mounting requires very small space. Screw holes covered by 2″ dial.

R. M. C. products are built for the finest sets that can be constructed.

Variocoupler.....$4.25
Variometer.....$4.25

Write for catalog of other diamond weave coils, and Radio Frequency Transformer.

THE RADIO MANUFACTURING COMPANY
of Springfield, Massachusetts
Dept. B **97 Dwight Street**

Acoustically Correct

The Trimm extra large Loud Speaker unit with its wonderful ADJUSTO instantly regulating loud speaker to signal strength insures greatest volume without flaws or distortion. At three prices:

ACOUSTICOLA

Standard Model with non-metallic horn, 21½″ high; bell 10″ diam.....**$22.50**

ACOUSTICOLA GRAND

With solid Cast Aluminum Horn; the world's finest loud speaker.....**$35.00**

ACOUSTICOLA

Phonograph Attachment **$10.00**

TRIMM High Grade HEADSETS

"Professional" model-3000 ohm.. .**$7.65**
"Dependable" model-2400 ohm.. .**$5.00**

Any Trimm product shipped and sold on approval and Guaranteed FOR LIFE. Write for descriptive folders. Mention your dealer's name.

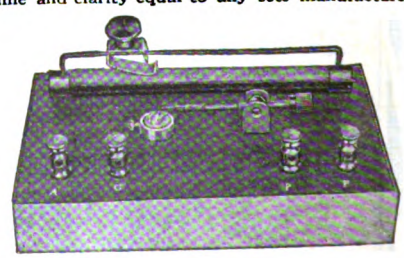
TRIMM RADIO MFG. CO.
Dept. 51
24-30 S. Clinton St., Chicago, Ill.

INSTRUMENT MAKERS
DEPENDABLE TESCO PRODUCTS
SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



FREE FAMOUS TESCO RADIO Crystal Set (Shown in Cut)

To introduce the wonderful T-B-H radio headset we will give absolutely free of charge, the most efficient crystal receiver on the market.

SEND NO MONEY

Just pay postman $5.00 plus postage. Money refunded if not absolutely satisfied.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.

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Boys have built the radio business

METEORIC, magic, unbelievable—that describes the stupendous growth of the radio business. The demand for sets and parts has increased 60,000 per cent in two years. What has caused this surge of radio interest? The contagious, resistless, energetic enthusiasm of boys.

The lure of radio has caught the imagination of youth. All over the country a vast majority of radio sales are made to boys, or to adults purchasing for boys. To the very limit of his means a boy buys his own equipment, but, lacking funds, he so convinces dad of his desire for radio, and of his knowledge of construction, installation and operation, that dad digs deep and buys the best his pocket affords.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

goes straight to the source of radio sales. Five hundred thousand go-getting sons of well-to-do parents read it regularly from cover to cover. Dyed-in-the-wool radio fans, they turn to its advertising columns for the equipment to supply their radio needs.

Averaging 15½ to 16 years old, their knowledge of radio commands the respect and confidence of their elders; their buying power is large, and their influence on buying decisive. Your advertisement, broadcasted to these up-to-the-minute, radio-saturated boys, will find the greatest market in the world tuned in and listening eagerly.

Start the new year with a message to the army of AMERICAN BOY readers. Copy for January should reach us by November fifteenth.

THE SPRAGUE PUBLISHING COMPANY
(Member A.B.C.)
548 Lafayette Boulevard, Detroit, Mich.

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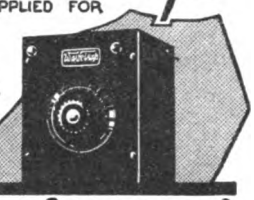
FERBEND

TRADE MARK

Wave Trap

PATENT APPLIED FOR

The *Original* Wave Filter



Stops Interference!

Eliminates interfering stations.
Improves the selectivity of the set.
Eliminates local broadcasting.
Selects between conflicting stations.
Simplifies tuning.
Often increases signal strength.
Reduces howling and squealing.

The WAVE TRAP is mounted on a Formica panel in a beautiful mahogany finished cabinet 6x5x6, and is a high-grade instrument throughout enhancing the appearance of the most expensive sets.

8.50 CHARGES PREPAID

Ferbend Electric Co.
21 E. SOUTH WATER. ST.
CHICAGO

Circular on request

KEYSTONE

RADIO LIGHTNING ARRESTERS

Should be on every aerial the year round. Provides highly efficient lightning and static protection for the home. Fully approved by Fire Underwriters. Can be installed out-doors. Has no vacuum to lose. Install one in your aerial lead now—be safe.

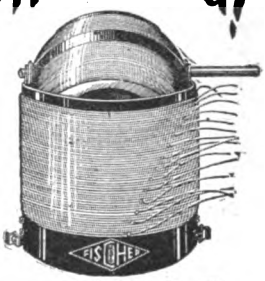
This pioneer radio arrester is backed by 31 years experience in lightning arrester design.

For sale by Dealers everywhere, or sent post-paid for $2.00. Write for circular.

Electric Service Supplies Co.
17 & Cambria Sts.
Philadelphia

Monadnock Bldg., Chicago
50 Church St., New York

Approved!



Approved by Radio Experts for Radio Amateurs

Approved because:—

Wave length is 550 Meters; 16 soldered leads; straight wound stator on genuine bakelite tubing; kiln dried rotor; Fahnestock spring clip connections; non-conductive adhesive. You can

GET ONE FOR $3.50

20 Diagrams Free with Each

For sale at your dealer's—otherwise send the $3.50 directly to the manufacturers and you will be supplied.

G. H. FISCHER & CO.

123 Liberty Street New York City

NEW TYPE

Variable Resistance Leak

ONLY THE KNOB

SHOWS ON THE PANEL

This device is especially built for use as a tuning instrument. Its construction is such that it will withstand unusual usage. Fully guaranteed. **Absolutely no pencil markings.** Can be mounted on any panel in a few seconds. It will enable you to get stations you have never heard before.

Complete with either .00025 or .0005 Freshman Condenser **$1.00**

Without Condenser.... **75c**

At your dealers, otherwise send purchase price and you will be supplied without further charge

Chas. Freshman Co. Inc.
Radio Condenser Products

106 Seventh Avenue, New York

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Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

A. J. HAYNES

Assoc. Institute of Radio Engineers
Designer of the Haynes Circuit

PARTS FOR THE FAMOUS HAYNES CIRCUIT

1000 Miles for $15.00

The Identical Parts Used by Mr. Haynes in His Own Personal Receiving Set—Assuring the Utmost in Selectivity, Long Distance Range, Economy, and Simplicity of Arrangement. Invaluable to experimenters converting ordinary, simple regenerative sets to include the Haynes Circuit

LAURENCE M. COCKADAY, R. E., describes the Haynes Circuit on page 222 of September Popular Radio. Reprints of this interesting article will be mailed by us anywhere upon receipt of a 2c. stamp. Also Mr. Cockaday's article in October issue of Popular Radio telling how to add a Two-Stage Audio Frequency Amplifier to the Haynes Circuit.

The appeal of the Haynes Circuit is universal. To the experienced amateur because of its astonishing long reception and wonderful selectivity; to the radio novice because of its easy construction and operation. So simple that no one can possibly go wrong.

The Haynes Condenser

$3.50

Meets every requirement—extreme low minimum capacity and maximum capacity of exactly .00023 mfds. No other condenser achieves just the right balance between perfect selectivity and over critical adjustment.

The Haynes Bank Wound Coupler

$4.35

Furnished with only the taps you actually use and just the right number of turns on the secondary. Bank winding provides 100% efficiency on higher broadcasting wave lengths.

For Radio Experimenters

Haynes-Griffin Oscillator Coupler $3.50
F. & K. .0005 Microtune Vernier Condenser—each $5.80
H.-G. 20 ohm Rheostat $.85
Dubilier .005 Fixed Condenser . . . . . $.60
Fada Socket $1.00

1000 Miles for $15.00

The outstanding feature of the Haynes Circuit is its simplicity and compactness of arrangement with all instruments panel mounted.

Most experimenters will find it well worth their while to substitute parts recommended by Mr. Haynes for those they may have on hand.

Haynes .00023 Condenser	$3.50
Haynes Bank Wound Coupler	4.35
Fada Rheostat	.75
Fada Socket (Panel Mounting)	1.00
Switch Arms	.20
4 Switch Points and 2 Stops	.06
10 Binding Posts	.50
2 3-inch Dials	.90
1 Dubilier Grid Condenser .00025 mfds. (with leak mounting)	.45
1 Grid Leak 1 meg	.35
Bus Bar, Solder, Copper Lugs and all miscellaneous material	.55
7x15 Grade A Hard Rubber Panel	1.50
Panel Drilled for Mounting all the above instruments (extra)	1.50

Accessories

7 x 15 solid mahogany cabinet, piano finish, $4.25; Haynes-Griffin Head Phones (2200 ohms) $4.75; W. D, 12, U V 201 A or U V 199 Vacuum tubes, $6.50; 22½ volt variable B Batteries, $1.25; 1½ volt dry cell A batteries, $ .40 each.

Complete parts to build the Haynes Two-Stage Amplifier cost $15.00 additional, including drilled panel. Tubes, cabinet, and batteries are not included at this price.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River

HAYNES-GRIFFIN RADIO SERVICE, Inc. 41 W. 43rd St. New York City

New York's Largest Radio Store

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POPULAR RADIO with Your Other Favorites—at Special Club Prices!

Your pick of these leading magazines at reduced rates in combination with a year's subscription to POPULAR RADIO

GLANCE over this big list of magazine bargains that have been arranged for your benefit. Here is your chance to get almost any magazine you want—and by ordering *now* with a year's subscription to POPULAR RADIO you get *both* magazines at special low prices.

If you are already a subscriber to POPULAR RADIO or to any of these other magazines, these special club offers allow you the privilege of renewing or extending your subscription *at a considerable saving of money.*

As you know, the subscription price of POPULAR RADIO will soon advance from $2 to $3 a year. Yet practically all of these magazine combinations are figured at a price for each magazine that is lower than even the present subscription price.

Fill your magazine requirements *now* for the coming year and save money. Simply check the offer you want and mail the coupon below, with your remittance. All subscription prices quoted are for one full year, and may be sent to *one* or to *separate addresses* unless otherwise noted.

But do not delay. These offers are good only until December 15th, 1923. After that date POPULAR RADIO advances in price and these prices will be withdrawn. Safeguard yourself *now* against POPULAR RADIO's raise in price, and in addition get these other magazines at special bargain club rates!

POPULAR RADIO, Dept. 111,
9 East 40th Street, New York City.

Enclosed is $..... Please see that yearly subscriptions are at once entered in my name for each of the magazines I have checked in the special bargain club list at the right.

Name.....

Street and Number.....

City.....State.....

(If not a NEW subscription, please mark R after the name of the magazine, to indicate RENEWAL.)

Prices for Canada and foreign countries will be quoted on request.

McCall's Popular Radio $3.00 Reg. For..... **$2.40**	**Modern Priscilla Popular Radio** $4.00 Reg. For..... **$3.25**
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Or You Can Make Up Your Own Club of POPULAR RADIO With:

American Boy	$4.00 reg., for...	$3.75
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Mentor	6.00 reg., for...	5.25
Movie Weekly	7.00 reg., for...	6.25
People's Home Journal	3.25 reg., for...	2.85
Photoplay	4.50 reg., for...	4.25
Physical Culture	5.00 reg., for...	4.25
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QST	4.00 reg., for...	3.60
Radio	4.50 reg., for...	4.00
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Radio Digest (52 issues)	7.00 reg., for...	6.25
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Wireless Age	4.50 reg., for...	4.00
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Note: If you wish any TWO or more of these magazines with POPULAR RADIO, simply deduct $1.75 from the bargain club price quoted, then add POPULAR RADIO at $1.75. For example:

Collier's	$3.75 less $1.75=	$2.00
Radio News	4.00 less 1.75=	2.25
POPULAR RADIO, added at only		1.75
Remit this amount		**$6.00**

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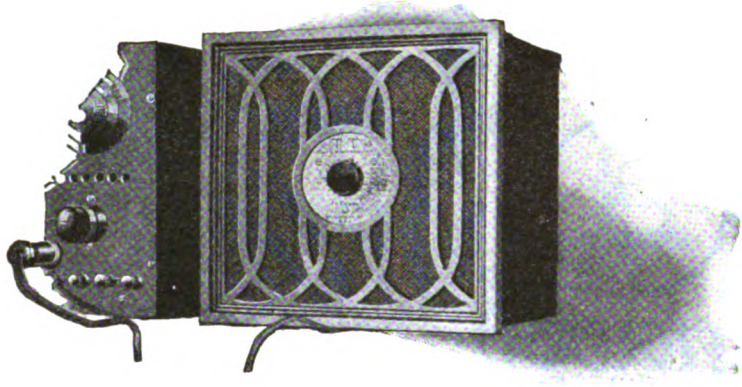


Where do you keep your radio?

Gone is the day when radio was called "wireless" and kept in the attic or the kitchen. Today, radio is in the same room with the piano, phonograph and the floor lamp, for it is furniture and should be selected as furniture on a basis of beauty as well as utility. In other words

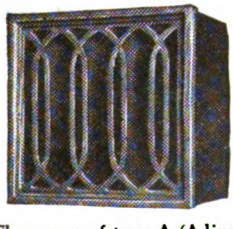
It's time to consider appearances

This applies particularly to loud speakers. Timmons Talkers, with their symmetrical lines and the rich hand-rubbed mahogany finish of their cabinets and grills are the most beautiful loud speakers in the world.

We have also perfected the most efficient method of tone reproduction ever known. It is ***reflected*** tone. Two concealed metal horns are used. Both are surfaced with "acousticoat"—a substance which makes them absolutely dead to distortion and false tones. Everything is heard as naturally as it is broadcast.

And now we ask you to hear and see the result of our work—the new Timmons Talkers. Your dealer carries both models—A, $35; N, $25.

Ask him for our folder "Volume without Noise"—or write us

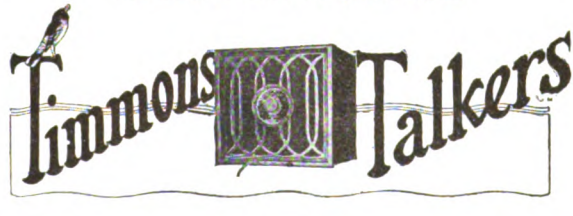


The screen of type A (Adjustable) is rich bronzed gold. Type N (Non-adjustable) has a screen of copper-color mercerized Madras.

J.S.TIMMONS

339 East Tulpehocken St.
Germantown, Phila., Pa.

Manufacturer of Radio and Loud Speaking Telephone Apparatus



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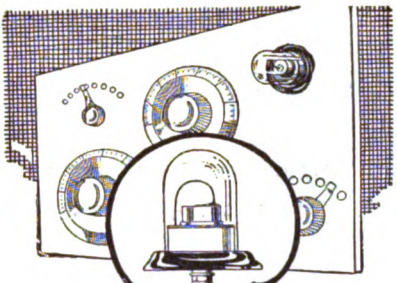

Grewol
THE PERMANENT DETECTOR

OFTEN imitated but never equalled. Maximum detector efficiency made constant, lasting. No flimsy cat-whisker; no parts to wear loose, no hunting for the sensitive spot. The GREWOL is proof against all ordinary detector troubles. The *only* detector for reflex, duplex and all circuits. Fully patented. Unconditionally guaranteed. **$2.00**

Tested and approved by Jack Binns, radio editor of the N. Y. Tribune.

If your dealer has no GREWOLS, send $2. to us with your dealer's name.

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For Radio Aerial Installation

THE BULL DOG MAST SEAT

FILLS A LONG FELT WANT by enabling anyone to install a firm and rigid mast, on either a peaked or metal ridge roll type of roof, with ordinary tools found around the home, thereby eliminating customary trouble, labor and expense. Supplying neat, substantial construction throughout the entire aerial.

Seat for 1½" mast, hinged type	$3.00
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Head Set $4.50

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A head set far superior to the average and just as good as the best. Equally good for all distances.

A loud speaker of superior qualities. Reproduces signals with no distortion at high amplification. A home instrument at a very moderate price.

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KING OF ALL

Pick Up Distant Stations Easier
with
The BROCKWAY VARIABLE CONDENSER

It gives greater efficiency in radio frequency, reflex neutrodyne and other critical circuits. Combines advantages that no other condenser can give.

Easier to Adjust
than a vernier. Two complete revolutions of dial (720 degrees movement) make accurate tuning easy.

Saves Space
behind panel, leaving more room for other instruments, tubes, B batteries, etc.

Improves Any Circuit
requiring 11 to 43 plate condenser. Gives longer distance reception.

If your dealer has no Brockway Variable Condenser in stock, ask him to order for you; or we'll send postpaid on receipt of price with dealer's name and address.

PRICE $3.50.

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COLISEUM

NOVEMBER

20th to 25th

TUESDAY to SUNDAY
INCLUSIVE

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and Associated Industries and Conclave of Manufacturers, Distributors, Jobbers—Dealers and Radiophans

A Contest for Amateur Builders of Radio Receiving Sets

For the best home-made receiving set built by any amateur in the United States, using any hook-up:

First Prize $75.00 **Second Prize $50.00** **Third Prize $25.00**

All sets entered in this contest to be exhibited in the Show. Contest opens October 15th. Sets must be in by November 18th. For further details and Entry Blanks write to Contest Dept., Chicago Radio Show, 127 North Dearborn Street, Chicago, Ill.

The amateur exhibit will be in addition to the exhibits of all the leading radio manufacturers. Manufacturers who have not as yet obtained their allotment of space are advised to get into immediate communication with the management of the SHOW.

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Do not delay filling out and mailing the attached coupon. This offer is good only until December 15th, 1923. After that date all subscriptions to POPULAR RADIO will be at the rate of $3 a year. By taking advantage of this offer now, you save from one to three dollars.

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The Romance of Science

CONQUESTS of science were the real achievements of Egypt's rulers. Instead of physical prowess, they sought the laurels of intellectual supremacy. Battles became experiments. Physics, astronomy, alchemy became the chessmen of their leisure. Where other nations plunged into wars and devastation, the Egyptians gave over their vigils to the investigation of natural phenomena.

To symbolize this intellectual power and their ability to create, they conceived the Sphynx, and with unparalleled skill and persistence engraved their triumph on the face of History.

If you assemble your radio parts from plan or book, take time to drink in the romance of radio art. Know on what laws the perfection of your receiving set depends. To acquire such knowledge is not a boresome study, but an absorbing recreation. As you read, you will understand the impelling appeal of science which has ever tempted Masterbuilders to create craftsman-like products which are more than adaptations of existing designs.

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Cardwell rotor-grounded condensers afford entire absence of body capacity effects and permit fine tuning of the most distant stations. They have such infinitesimal losses, no laboratory has been able to measure them. Their mechanical ruggedness insures long usage and freedom from annoying difficulties. Not only will Cardwells often add a thousand miles to your receiving range but they permit the entire elimination of interference.

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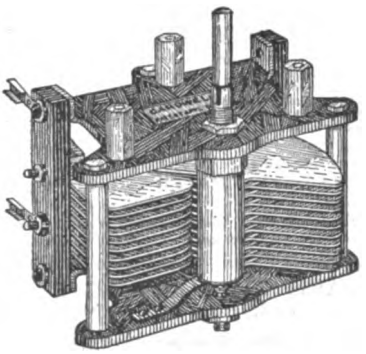

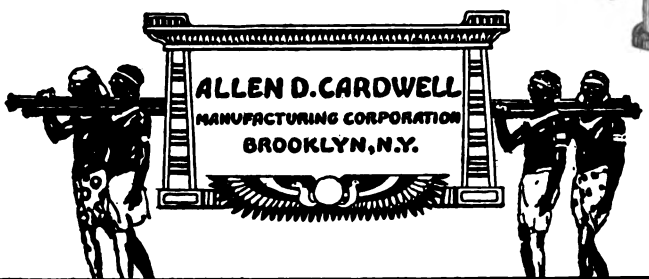

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Hook-up directions and material list furnished free with each set of coils.

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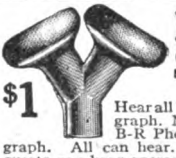

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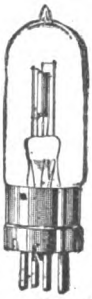

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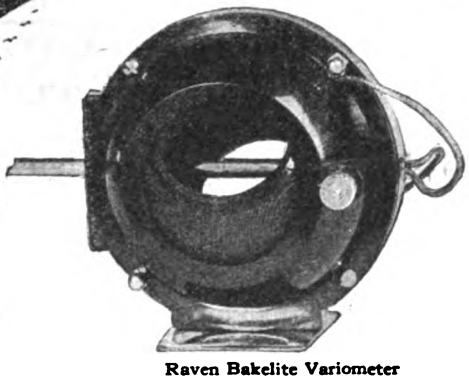

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are the height of perfection. The result of long and rigid laboratory research.

Made of Genuine Bakelite with the hardware used nickel plated throughout.

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Made to conform with all wave lengths for both amateur and broadcast listeners.

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All Instruments are thoroughly inspected before leaving our factory and any purchase made by a Jobber, Retailer or User found defective in any way will be replaced by us with a new instrument free of charge to the purchaser.

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Catalog No. B-102

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Wooden Variometer	**C-101**
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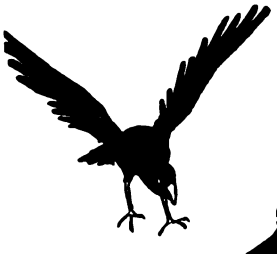

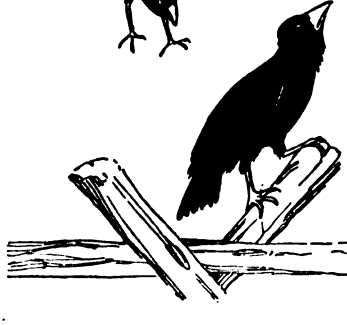

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Standard parts for this sensational circuit—panel, coils, condensers, verniers, variable resistance, vernier rheostat, socket, double jack, dials, switch, contact points, posts, busbar wire, spaghetti, etc. (no tubes or phones).

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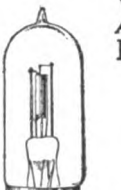

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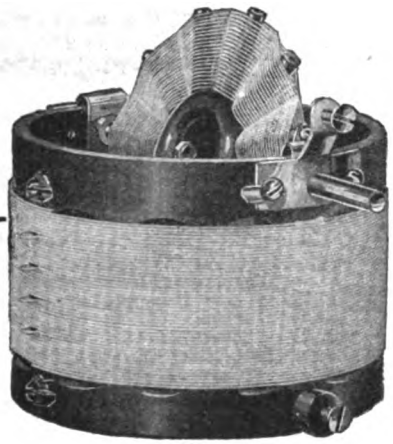

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ROTOR—Spider Web design. 50 turns No. 25 d.s.c. wire
STATOR—50 turns, No. 20 d.s.c. wire. 5 taps. SHAFT LENGTHS—for ⅛ in., ⅜ in. and ¼ in. panels.
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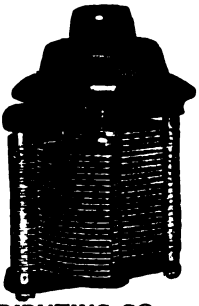

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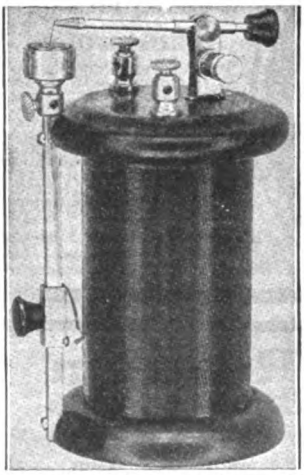

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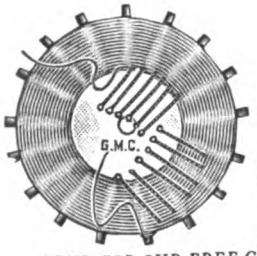

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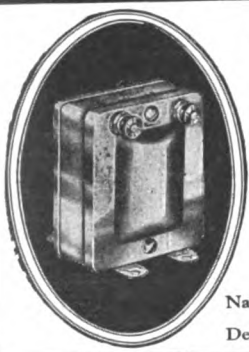

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The New 6 to 1 Ratio National Transformer is for use on the first stage of amplification. Its greater ratio means increased volume, but the tone qualities that characterize the 3½ to 1 ratio have been fully retained. Price of 6 to 1 ratio $4.50 postpaid; of the 3½ to 1 ratio, $4.00 postpaid.
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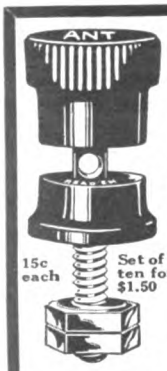

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Simplify the most complicated hook-up
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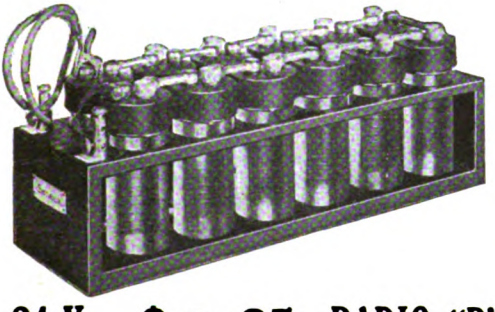

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Automatic Plug

Connected,—disconnected in a moment. Pulling tightens grip on cord tips. Lever instantly releases. Smooth, positive contact. Time and effort economized. Each Saturn Plug unconditionally guaranteed. Extra satisfaction at the same price.

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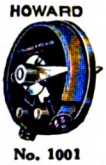

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No. 1001

6½ Ohm Rheostat.....$1.10
25 Ohm Rheostat..... 1.10
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Ask the man to show you the **Howard** line of quality Radio Merchandise. Every piece is sold with the **guarantee** of **satisfactory** performance.

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PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

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May, 1922

—Harnessing waves to wire.
—How to make and install your own Receiving Set.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How to use your Radio Set in summer.
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.
—How to use your Phonograph as a loud speaker.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—Radio on your pleasure boat.
—How to make a variable condenser.
—The foolish fear of lightning.

September, 1922

—How to build the Armstrong Circuit Receiver.
—How the Vacuum Tube works.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How the crystal detector detects.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—Right and wrong ways of adjusting the Regenerative Receiver.
—How to make a novel variocoupler.

December, 1922

—Radio on your motor car.
—How to select the best coil for your set.
—How to make and use a loading coil.
—How the Vacuum Tube detects.
—A Receiving Set that takes notes.
—How to make a series-antenna condenser.

January, 1923

(This issue in which appeared Mr. Cockaday's full description of his "DX" Regenerative Receiver is completely exhausted. A special Reprint of Mr. Cockaday's article may be had, however, for 22 cents in stamps.

February, 1923

—20 tips on tuning.
—The Hoffman measurement charts.
—Shall I use a "hard" or "soft" tube?
—A novel tuner for shutting out interference.
—How the Audio-frequency amplifier works.
—Pointers on aerials.
—How to add an Audio-frequency amplifier.

March, 1923

—A Receiver without batteries.
—How to get the greatest efficiency out of your Radio circuits.
—How to make a one or two-step Audio-frequency Amplifier.
—How to make a Multi-Layer Coil.

April, 1923

—Regeneration without Radiation.
—A crystal detector from a spool.
—How the Vacuum Tube detects and rectifies.
—How to make a simple single tube Receiving Set.
—Circuit diagram of the Cockaday DX-3 Circuit Tuner, with instructions on how to add three stages of radio frequency.

May, 1923

(This issue, in which appeared Mr. Cockaday's description of his 4-Circuit Tuner, is completely exhausted. A special Reprint of Mr. Cockaday's article may be had, however, for 22 cents in stamps.

June, 1923

—How to use your Radio Set on your vacation.
—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.

July, 1923

—How to install your Radio Set on your boat.
—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923

—How to build a Tuned Radio Frequency Receiver.
—Measurement chart for determining the constants for a loop antenna.
—How to calibrate your wave meter.
—Circuit diagram of the Cockaday 4-Circuit Tuner adapted for use with dry-cell tubes.

September, 1923

—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

October, 1923

—Practical hints for Coil Calculations.
—How to make a Two-stage Audio frequency Amplifier.
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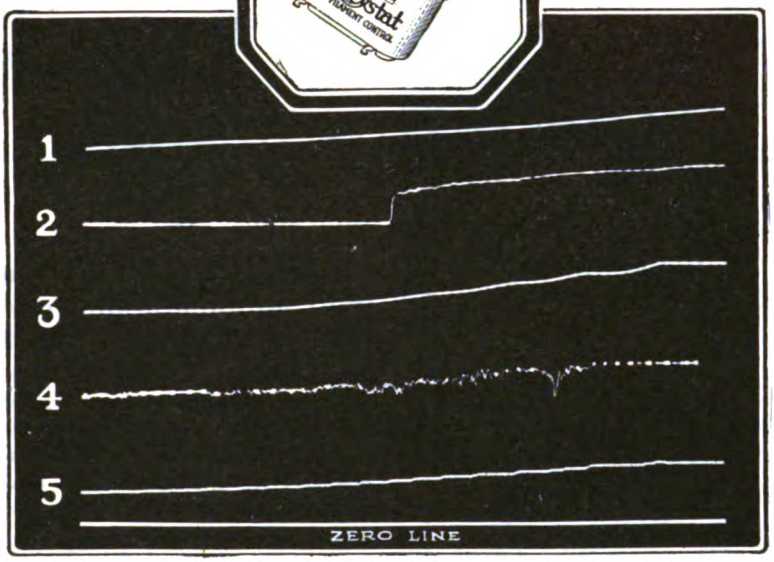

The Graphite Discs in the Universal Bradleystat Surpass All Other Resistors for Perfect Filament Control

SUBSTITUTES have been offered, from time to time, for the scientifically-treated graphite discs in the Universal Bradleystat. Carbon powder, dust, flakes and other materials have been tried without success.

For a time, such materials appear to give satisfactory service, but they soon pack into a solid mass and the filament control is destroyed.

The Allen-Bradley Co. has built graphite disc rheostats for over twenty years for battle ships, mines, rubber plants, textile mills and other places requiring smooth, stepless control. This wide experience has made possible the Universal Bradleystat, backed by a guarantee of excellence and performance which assures every Bradleystat purchaser of a filament control that is perfect and permanent.

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LABORATORY tests are made frequently to compare the performance of the Bradleystat with other types of filament control. A recent oscillograph test made at the University of Wisconsin is shown above to demonstrate conclusively the superiority of graphite discs over other resistance materials.

Curve No. 1 is the smooth perfect control of the Universal Bradleystat.

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Curves No. 4 and 5 illustrate the control of two types of wire rheostats.

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In Canada $2.50

Allen-Bradley Co.
Electric Controlling Apparatus
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All Reliable Dealers Sell the Bradleystat

THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER 20 YEARS

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A Brand New Grid Leak

WITH

Stepless Adjustment from ¼ to 10 Megohms

CROSLEY
MANUFACTURING CO.
RADIO DIVISION
CINCINNATI OHIO

September 8, 1923.

ALLEN-BRADLEY CO.
Milwaukee, Wis.

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I just received our laboratory report wherein the Bradleyleak is complimented very highly when compared with other adjustable leaks. The Bradleyleak gave smooth, uniform control without sudden alterations of the grid circuit, and is the only device tested in our laboratory which is stable in operation. We found it quite independent of atmospheric conditions, a factor not found in other adjustable leaks exceeding one megohm.

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Yours truly,

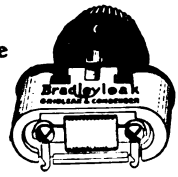
CROSLEY MANUFACTURING CO.

Crosley Laboratory Enthusiastic over this remarkable grid leak

THE Bradleyleak is now ready for you! After months of laboratory research, a new and better adjustable grid leak has been developed which provides a stepless range of resistance from ¼ to 10 megohms. This problem has defied radio engineers for a long time, but finally has been solved through the use of two columns of discs of special composition placed under the variable pressure of the Bradleyleak knob. Any conceivable resistance is obtained with utmost accuracy by turning the adjusting knob. When once adjusted, the setting is permanent. [Read the letter from the Crosley Manufacturing Company's Laboratory.]

The radio world has been waiting for a real adjustable grid leak. Here it is! There is no substitute for the Bradleyleak, either in performance or accuracy. It is furnished with a grid condenser, if you desire. Your dealer will get the Bradleyleak for you. Avoid unreliable makeshifts, and improve your tube efficiency by installing the Bradleyleak.

Retail Price
$1.85
P. P. 10c



Condenser .00025 mf. 35c extra

Unaffected by atmospheric conditions. Smooth and uniform in adjustment.

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THE PERFECT GRID LEAK

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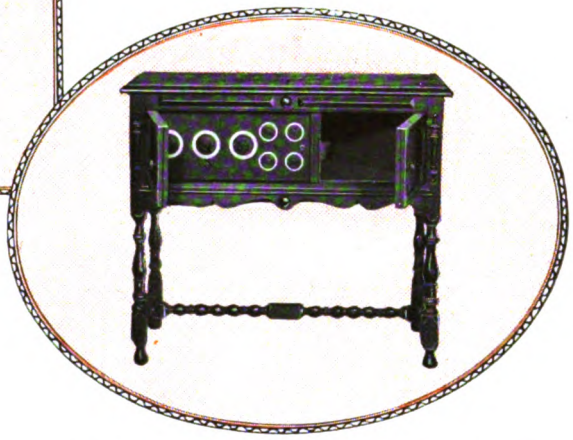
The New C & W Console Receiver

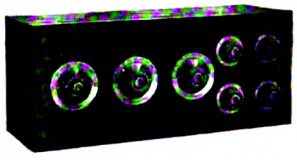
Completely Self Contained with Loud Speaker



A Moderate Priced Set that will make Radio Entertainment Permanent in Thousands of Homes.

Higher selectivity than any other instrument in its class—clearer signals by actual test—this three tube, double circuit Receiver is the last word in radio for the home.

Set is complete with 3UV 199 tubes; 3 large A Batteries; 3 B Batteries and Loud Speaker—ready for antennae and ground connections. Ask your Cutting and Washington dealer or write for illustrated catalog.



Cutting and Washington Receiver 11A—similar in mechanical design to console model, but of regular cabinet type. This C & W Model has enthusiastic users all over the United States. Write for illustrated catalog.

Cutting and Washington Receiver 12A—"Town and Country" model (portable type). A turn of a switch changes it from single circuit set for outing use, to a double circuit set for use in the home with permanent antennae. Ideal all purpose set.

Dealers: Write for full details of C & W Line and Dealer Plan, and copy of interesting book, "The Future of Radio Retailing." No obligation.

Cutting & Washington Radio Corp.
Kasota Building
Minneapolis Minn.

Cutting and Washington

Standard of Excellence in Radio Since 1914

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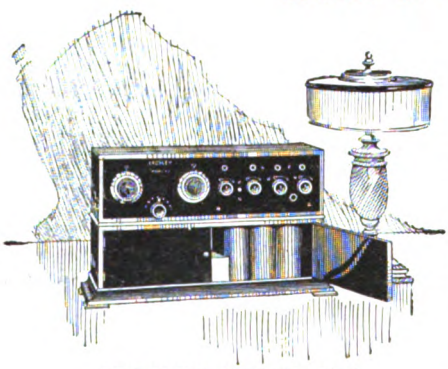
Abroad at Home
with a CROSLEY MODEL X-J

PRICE $65

Wonderful opera from New York, love songs from the tropics, dance music from Chicago; stock quotations, stirring speeches, amusing stories from where you will—all these pleasures and utilities are brought truly, clearly, right to your fireside, if you own a Crosley Model X-J Radio Receiver.

This beautiful new Crosley 4 tube Model contains the same units as the famous Crosley Model X, with added refinements of detail which make it even better. At bringing in distant stations, the Model X established many records during the past year. Sebring, Fla., continually heard Honolulu. A man writes from Nassau, British West Indies, "*First of all on Friday night, June 29, 1923, I heard Honolulu.*" He goes on to relate that practically all stations in the United States were brought in clear as a bell.

With the Crosley Model X-J even better receptions are assured. We unhesitatingly claim that it is the best radio receiver ever offered, regardless of price.



CROSLEY MODEL X-J

A 4 tube radio frequency set, incorporating one stage of Tuned Radio Frequency Amplification, Detector and two stages of Audio Frequency Amplification, with jack to plug in on three tubes for head phones; new Crosley multistats, universal rheostats for all makes of tubes; new condensor with molded plates; filament switch and other refinements of details. A mahogany battery cabinet which makes the set completely self containing may also be had to fit the Model X-J at a cost of only $16. See illustration above.
See this beautiful receiver at your dealers.

"List prices on our equipment West of the Rockies 10% higher. In Canada add duty."

For Sale by Good Dealers Everywhere

Write for free catalog which shows the complete Crosley line of instruments and parts. In it you will find just the receiver to suit your needs and pocketbook. Crosley Receivers without batteries, tubes and head phones range in price from the efficient **2 tube Model VI at $28** to the beautiful **Console Model at $150.**

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Boston Office, B. H. Smith, 755 Boylston Street, Room 316.

Chicago Office, 1311 Steger Building, 28 E. Jackson Blvd., R. A. Stemm, Mgr.

Philadelphia Office, J. H. Lyte, 65 North 63rd Street.

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CROSLEY
Better-Cost Less
Radio Products

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Edited by KENDALL BANNING

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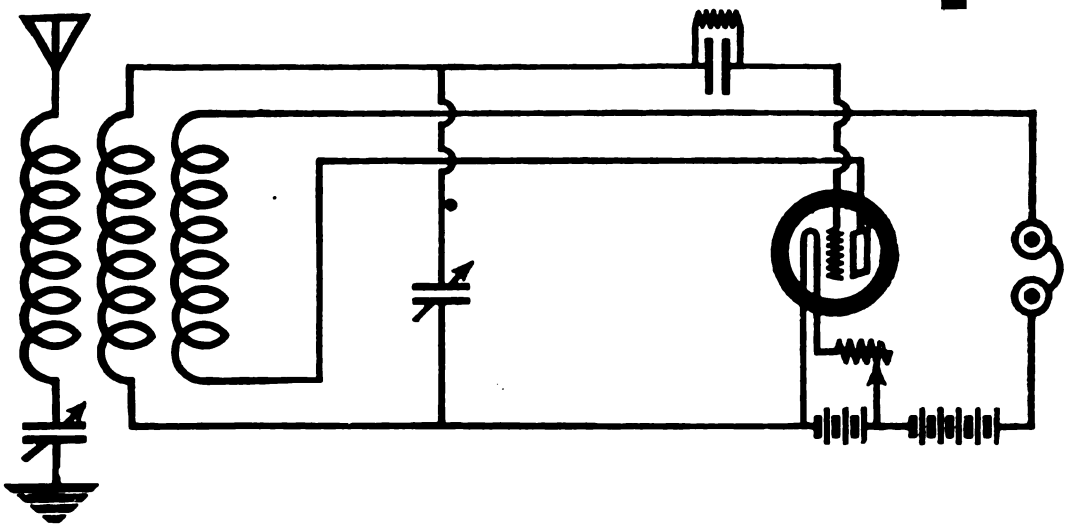

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How to Build a Simple Crystal Set—

How to Build the Super-Heterodyne-Receiv

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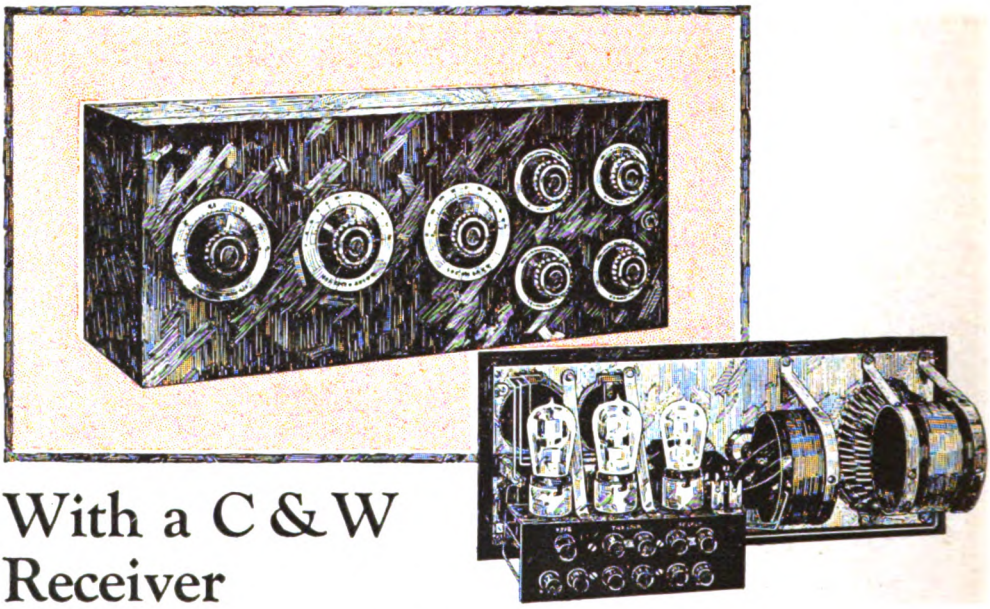
Get Your Station



With a C & W Receiver

Once you know the real thrill of Radio—once a slight turn of the dial gives you New York—Atlanta—San Francisco—you'll never be content to possess any but the most highly selective receiver—the set that will GET YOUR STATION if the station is to be had.

This is why you will sooner or later choose a genuine C & W Receiver—built by two of America's foremost radio engineers—designers of U. S. Naval and Marine Equipment—men who have been building the highest type of commercial apparatus for more than 10 years.

Actual tests have proved C & W Sets more highly selective than any others in their class. Choose the best set *first*—why experiment?

C & W Receiver 11A—(Armstrong Patent). A 3-tube, special double circuit set. Note the simplicity of parts. Easily operated—remarkably long range and clear reception—the set used in the famous C & W selectivity tests. Uses 6-volt storage battery. All wires back connected. Price (without batteries or tubes)..$135

The Cutting & Washington Radio Corp.
Minneapolis, Minn.

DEALERS—*write for complete details of the C & W Merchandising Plan, including your own magazine, FREE, to mail to prospects*

Cutting and Washington

Standard of Excellence in Radio Since 1914

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KENNEDY

The Royalty *of Radio*

The Colin B. Kennedy Co., internationally renowned for their QUALITY RECEIVING SETS, are equipping all their sets with Thordarson super-transformers.

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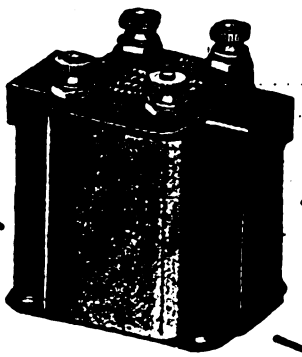

CONVINCED

ZENITH

TRADE MARK

The Zenith Radio Corporation, manufacturers of LONG DISTANCE RADIO RECEIVERS, famous for the Berengaria record and their accomplishments on the S. S. Bowdoin at the North Pole, also have adopted Thordarson super-transformers as standard equipment.

SUPER TRANSFORMER

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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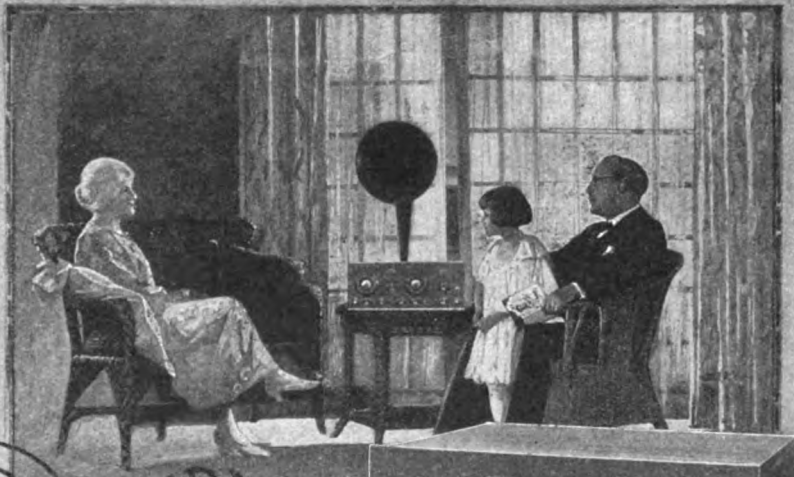
Broadcast Receiver-
Doctor Mu.

REGENERATION and Tuned Radio Frequency Amplification find their first successful combination in this Receiver. The 20-foot silk-covered wire, readily concealed behind the picture moulding, is the only antenna required.

The attractively finished walnut cabinet has compartments for all necessary batteries.

Write for "GREBE Radio in the Well-Appointed Home"



GREBE RADIO

A. H. GREBE & COMPANY, Inc.
Richmond Hill, N.Y.
Western Branch, 451 East 3rd St., Los Angeles, Cal.

Licensed under Armstrong U. S. Pat. No. 1,113,149

Type CR-12

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PAGES WITH THE EDITOR

OUT of the wilds of Canada comes a letter from an Irate Reader who peremptorily orders his subscription cancelled because of "the tacit approval of bootlegging and contempt of the law expressed in an article by "a writer called Williams" in our September number.

* * *

So far as the Editor knows, this cancellation is the first one ever received from an Irate Subscriber by POPULAR RADIO. It is at least a gratification to know that the irritation was not occasioned by a technical error in our pages or by a misstatement of a fact!

* * *

CANCELLATIONS due to a subscriber's disagreement with a point of view expressed by a contributor are so rare—particularly in scientific magazines which appeal primarily to open-minded seekers of the truth—as to attract comment. The Editor does not and obviously cannot commit either himself or the magazine to the opinions of the contributors. If any considerable portion of our readers shared our Canadian reader's censorious mental attitude, what in the world would have happened to our large and growing subscription list following the famous controversy in our pages between Sir Oliver Lodge and Dr. Charles P. Steinmetz on the Ether Hypothesis? Or between Dr. Elihu Thomson, Sir Oliver Lodge, General Squier and Dr. Reginald A. Fessenden on the Gliding Wave Theory?

* * *

As a matter of fact, "a writer named Williams" merely made the parenthetical observation (in his article descriptive of the broadcasting of his play) that "fortunately" Mr. Volstead's efforts to suppress cocktails were unsuccessful. This point of view is reported to be held by several million pretty good Americans and apparently too by a good many Canadians, who are presumably just as sincere in their convictions as is the Irate Subscriber. POPULAR RADIO neither disapproves nor endorses these opinions. Furthermore, the Editor expects to publish other opinions, provided that the contributors are persons of standing whose views command consideration.

* * *

"A WRITER called Williams," in this case happens to be the internationally known novelist, Jesse Lynch Williams, Doctor of Letters, president of the Authors' League of America, member of the National Institute of Arts and Letters, a writer and publicist who has been honored by institutions of learning and a dramatist who is known here and abroad for his keen understanding of present-day people and present-day problems.

* * *

ONCE, when the Editor was on the staff of another magzaine, he lost an Irate Subscriber who bore a personal grudge against a certain author who had inconsiderately married the Irate Subscriber's sweetheart. And once he lost an Irate Subscriber because an illustration in the magazine showed a man firing a revolver—and the Irate Subscriber, being an avowed pacifist, disapproved even of *pictures* of guns! And once he lost an Irate Subscriber who was a Catholic and didn't believe that the magazine should employ a Jew as subscription agent—or perhaps it was the other way around.

* * *

BUT no amount of cancellations of subscriptions or advertising—(and, contrariwise, no amount of promises of contracts for either)—will divert the editorial policy of POPULAR RADIO or lead the Editor to publish or to suppress an honest opinion.

* * *

THE *editorial pages of* POPULAR RADIO *are not for sale*—to subscribers or to advertisers.

* * *

As this paragraph is being written, the cash price of POPULAR RADIO is 250,000,000 marks—although, of course, that trifling sum is no criterion of its *value*. "I wouldn't sell my May number for $10.00," writes an enthusiastic reader from Bethel, Conn. . . . Um! let's see, that's about 10,000,000,000 marks, isn't it?

* * *

THE author of the article on page 504 of this issue of POPULAR RADIO, John V. L. Hogan, is not only one of the most capable and widely experienced of radio experts in the world, but is adding to his scientific laurels an occasional sprig or two from the world of literature. His latest book, "The Outline of Radio," is perhaps the most understandable yet authoritative volume on the subject that the Editor has yet seen—comparable only to "Radio for Everyone" by our own Laurence M. Cockaday. And no praise could be fairer than that!

* * *

OUR enterprising subscription manager tells the Editor that he has arranged with numerous publishers for filling orders for POPULAR RADIO, in combination with other magazines, at special club rates.

"Our readers will profit well by taking advantage of some of these clubbing offers and filling the magazine requirements of their whole family for the coming year" he reports. "These special units, as announced in our advertisement in the current number, are priced lower than they can ever be priced again, and the offers are for a very limited time only. Why not tell our readers about them in *Pages with the Editor*?"

* * *

WHY not, indeed?

(*Continued on page* 8)

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TRADE MARK

Natural
Re-PRODUCTION

Atlas AMPLITONE LOUD SPEAKER

FOR Christmas give the radio enthusiast his fondest expectation—a perfect radio re-PRODUCER, the **Atlas Loud Speaker.** Natural re-PRODUCTION, identical with the original in the broadcasting studio. The patented "double diaphragm" responds uniformly to the full range of sound intensities. Adjustable to each individual set and receiving conditions. The **Atlas Loud Speaker** is a gift to an entire home.

Hear the **Atlas Loud Speaker** at your dealer's.

WARNING. Be sure you get the **genuine Atlas Loud Speaker** with our red tag factory guarantee! LIST PRICE **$25**

Write for Booklet "B"

Contains much helpful information

Sole Canadian Distributors
The Marconi Wireless Telegraph Company of Canada, Ltd.
Montreal, Canada

Letters from Users Requested

The remarkable re-PRODUCTION of **Atlas Loud Speakers** makes every owner enthusiastic. "Musical experts," writes a man in St. Paul, "have pronounced it the clearest reproduction they have ever heard." What results have you accomplished with your **Atlas Loud Speaker?** Write us about them—TODAY.

MANUFACTURED BY
Multiple Electric Products Co. Inc.
ORANGE ST. RADIO DIVISION NEWARK, N. J.

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(Continued from page 6)

From a photograph made for POPULAR RADIO

A CORNER OF THE EXPERIMENTAL LABORATORY OF *POPULAR RADIO*

Before the Technical Editor's article on the super-heterodyne receiver was written, the set was designed, built and put into successful operation. Then the Technical Editor told in detail how it was done.

YOU will find above a snapshot of a corner of the experimental laboratory conducted by our Technical Editor. This particular picture was made while the staff was actually working on the super-heterodyne set that is described in this issue.

* * *

EVERY *set and every circuit that is described in this magazine is built and tested before it appears in our pages.*

* * *

EVERY one of our "How-to-Build" articles is so carefully written and checked up that the possibility of error is remote. In order to insure successful results to the builder, the articles contain all the specific information that is necessary, ranging from the exact instruments that should be used to detailed and minute instructions as to where to drill the holes for the screws.

* * *

THERE are some radio parts, however, that POPULAR RADIO recommends its readers to buy outright rather than to try to make himself. The amateur—even the most experienced—has neither the experience nor the facilities for making his own vacuum tubes, for example. Nor has he the facilities for making such apparatus as audio-frequency transformers or couplers. It would be as unwise for the radio fan to try to make them as it would be for POPULAR RADIO to advise him to do so.

* * *

IF you fail to find in our "How-to-Build" series construction details for certain instruments, you may properly conclude that, in the opinion of POPULAR RADIO at least, the amateur should not attempt to construct them himself.

Kendall Banning

Editor, POPULAR RADIO

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An Appreciated Gift

Charges Radio and Auto Batteries at Home Over Night - For a Nickel!

For a friend who owns a radio set or automobile, what could be more appropriate than a gift which would eliminate the inconvenience and expense of taking his battery to a service station every time it requires recharging? The

GOLD SEAL
HOMCHARGER
The World's Most Popular Battery Charger

is such a gift, appropriately dressed up in a beautiful Christmas package, too. It charges any AUTO, RADIO or "B" storage battery in the simplest, quickest and most efficient manner possible. Connects to any lamp socket—operates silently—requires no watching. Fully automatic in operation—absolutely safe.

HOMCHARGER'S TEN POINTS OF SUPERIORITY

1. **Simple**—Only one moving and wearing part, replaceable after thousands of hours use for $1.00. Will last a lifetime.
2. **Efficient**—Uses less than one-half the current of any bulb or liquid type rectifier. Will charge any radio or automobile battery for a nickel.
3. **Quick**—Its high charging rate of 7 amperes eliminates long waiting for battery to become charged. Will charge any "A" or "B" battery over night, or three times as fast as a 2-ampere machine.
4. **Clean**—No expensive bulbs to break or acids to spill or replace. No acid fumes. Charges without muss, fuss or bother.
5. **Dependable**—Tungsten contacts insure continuous operation —prevent sticking and stopping.
6. **Fool-Proof**—Can be operated by anyone. Attach to lamp socket and connect battery either way, it will always charge. High-grade ammeter eliminates guess work.
7. **Safe**—No danger or shock or fire. Tested and approved by Fire Insurance Underwriters everywhere. Gives tapering charge—will not overheat or injure battery.
8. **Beautiful**—Mahogany and Gold Finish.
9. **Unqualifiedly Guaranteed.**
10. **Popularly Priced**—Retails at $18.50 complete ($25.00 Canada). No extras to buy. Sold by all dealers.

FREE BROADCASTING LIST. Ask your dealer or write direct for Free Homcharger List of Broadcasting Stations, and Circular Describing the Gold Seal Homcharger.

DEALERS! JOBBERS!

GOLD SEAL HOMCHARGERS in their attractive Xmas packages are going to be "best sellers" to the holiday trade. Write for our elaborate merchandising plans and then prepare to get your share of this big "Homcharger Xmas business."

***Insist on the* GOLD SEAL**

ACCEPT NO SUBSTITUTE. Like all good products, the HOMCHARGER has been widely imitated. No other charger is just as good. INSIST on seeing our registered trade-mark, the "GOLD SEAL," on nameplate and carton before purchasing.

GENUINE GOLD SEAL HOMCHARGER UNQUALIFIEDLY GUARANTEED

The Automatic Electrical Devices Co., 132 West Third St., Cincinnati, O.

Largest Manufacturers of Vibrating Rectifiers in the World

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The Outstanding Value *in* New Kennedy Radio Sets

The new Kennedy Radio Model V is everywhere acknowledged as the one outstanding value in the radio field today.

The receiving unit in Model V is a distinct advance in radio engineering. It is a special development of extensive research in the Kennedy Laboratories and was produced in response to an insistent, popular demand for more simplified apparatus. After initial settings are made, all tuning is controlled by a single dial. Yet, with this extreme simplicity of operation the selectivity of the earlier Kennedy models has been retained. The new unit responds to all broadcast wave-lengths and operates on any ordinary antenna.

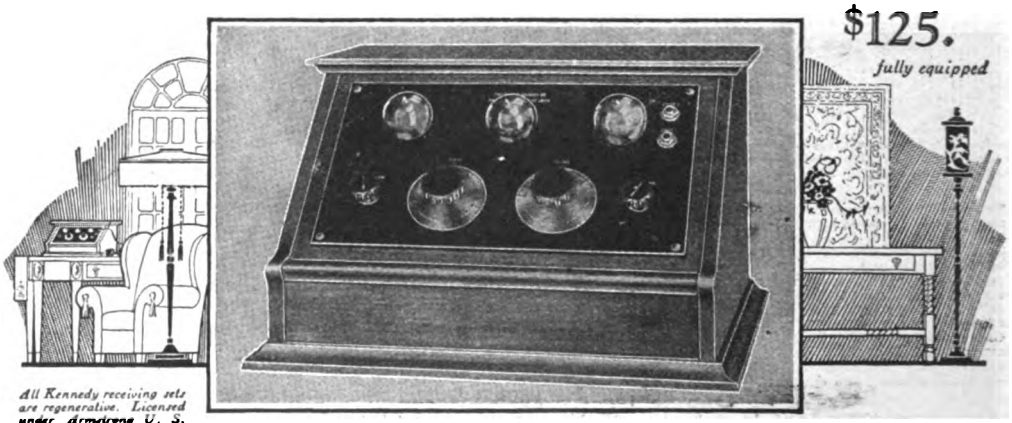
The cabinet is of solid mahogany and follows a pleasing design that adapts itself to home surroundings. Equipment includes all tubes, dry batteries, Kennedy phones and plug—batteries are fully enclosed. Price, complete, $125.00.

More elaborate Kennedy furniture models range from $285.00 to $825.00, completely equipped, including built-in loud speaker.

See the new Kennedy furniture models at your dealer or write us for fully illustrated particulars.

THE COLIN B. KENNEDY COMPANY

SAINT LOUIS SAN FRANCISCO



All Kennedy receiving sets are regenerative. Licensed under Armstrong U. S. Patent No. 1,113,149.

KENNEDY

The Royalty of Radio

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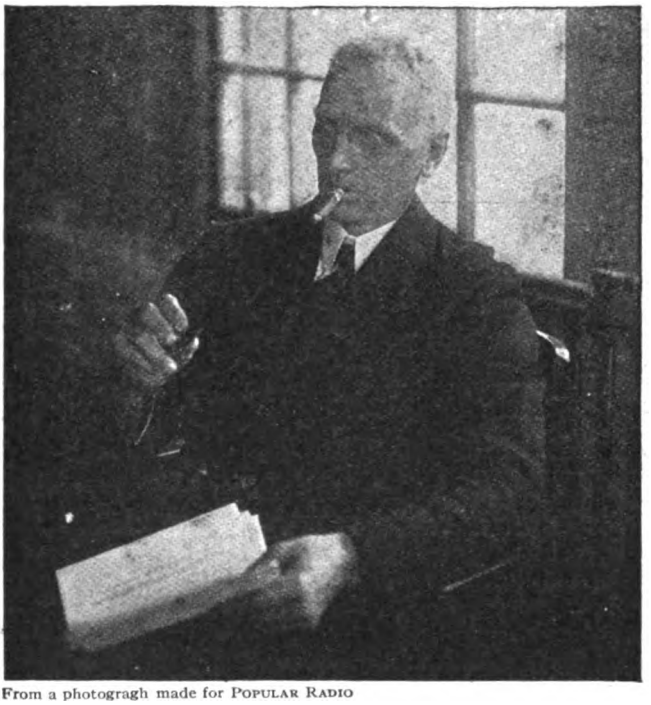

From a photograph made for POPULAR RADIO

The Inventor of the Radio Furnace

AMONG the first American experiments with radio were those made at the University of Texas in 1896 by Dr. E. F. Northrup. Dr. Northrup's most recent achievement is the invention of a furnace that melts the most refractory metals by means of radio waves. He will describe this in an early number of POPULAR RADIO.

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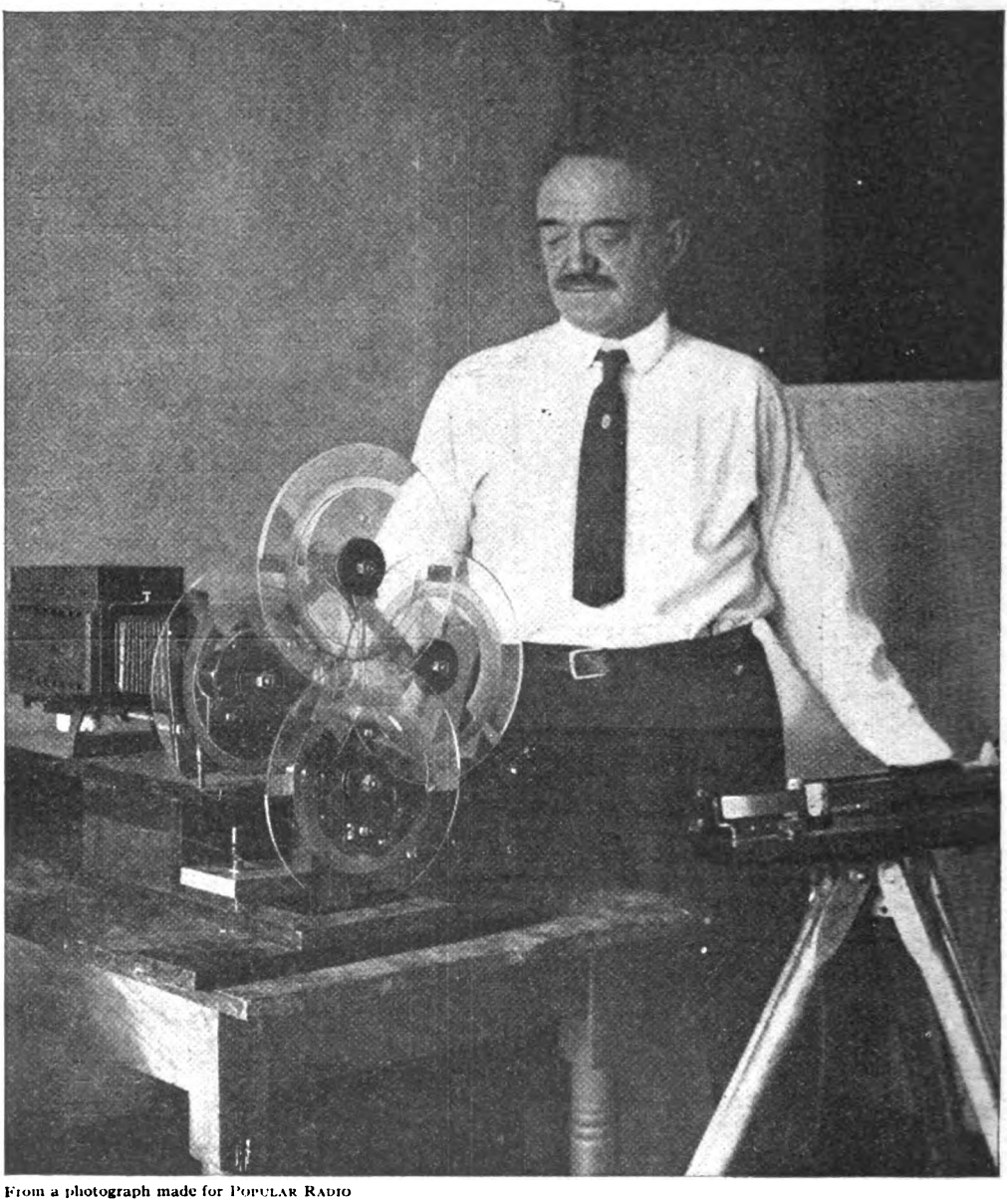

From a photograph made for POPULAR RADIO

The First Man to See by Radio

This modest genius, Mr. C. Francis Jenkins, of Washington, D. C., believes in letting his inventions make their way in the world on merit alone. Although he is less known to newspaper readers than many other inventors of far less accomplishment, Mr. Jenkins already has to his credit several important contributions to the production of motion pictures as well as to radio. His most recent invention combines these fields in the "radio movies," described in the article that starts on the page opposite.

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Popular Radio

VOLUME IV DECEMBER, 1923 NUMBER 6

THE NEW

RADIO MOVIES

In this authoritative article Mr. Davis describes for the first time an invention that some scientists believe to be one of the most important ever made in the whole science of radio. It is not too much to say that it may result in permitting you to actually *see* any part of the world—its people, its street scenes, its great events and spectacles—without leaving your own fireside.

By WATSON DAVIS

WHEN I talked to C. Francis Jenkins over the telephone and he asked me to come up to his laboratory, I was not surprised and startled that he and I could talk over a copper wire. Telephoning is a common performance. Even the nightly radio voices in the ether are no longer the marvel they were a mere two years ago.

But, when Mr. Jenkins asked me to watch a screen in his laboratory which was shut off from the rest of the room and when I *saw* him wave his hand to me, although my back was turned to him, it was unusual.

I was seeing by radio!

But Mr. Jenkins has done unusual and unprecedented things before. Every ordinary motion picture projector contains a vital principle invented by him. Readers of POPULAR RADIO know also that he has within the last year made it possible to send diagrams, messages written in Chinese characters, and even photographs by wire and radio.*

Sending and receiving sets for transmitting still pictures by radio were in his laboratory, and it was plain that this apparatus for radio vision, a new assembly of disks, motors, lenses and lights, was related to the more finished and mature equipment that has been successful in sending pictures and diagrams through thin air.

In reply to my hardly pronounced "How?" Mr. Jenkins showed how he had made the movement of his fingers and hand visible by radio. The apparatus seemed extremely simple, certainly no more complex than the telephone when Bell first operated it. A magic lantern, the same as thousands in ordinary use, was projecting its shaft of light through a disk that revolved at

*The Jenkins method of sending pictures by radio was described in "Seeing by Radio" by Watson Davis, POPULAR RADIO, April, 1923.

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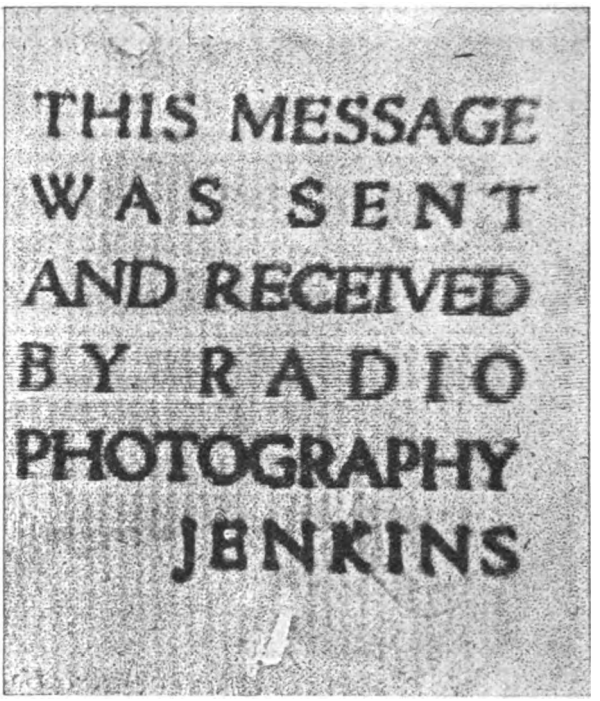

AN EXAMPLE OF FACSIMILE REPRODUCTION OF READING MATTER (OR PICTURE) BY THE JENKINS MACHINE

The transmission of a "still picture" by radio was the first step in the transmission of motion pictures—which are but a series of still pictures. Now the inventor is transmitting actual scenes directly from the moving objects.

high speed. The light fell on an opening in a rectangular box, supported, much like a small camera, on a heavy tripod placed half way across the room. From the black box on the tripod wires ran to a radio transmitting set that was heavily screened to keep stray and troublesome electric currents from getting in the way. When a wave of the hand was to be transmitted, Mr. Jenkins simply inserted his fingers into the space where the lantern slide holder of the ordinary stereopticon is placed.

The object of the whirling disk and stereopticon, Mr. Jenkins told me, was to impress the shadow of the moving fingers and hand, portion by portion, upon the light-sensitive cell that was contained in the camera-like black box on the tripod. How this is done will be explained later. But the result is that the variations in light that this cell receives are translated into variations in electric current, just as the variations in sound that enter the telephone transmitter exit upon the wires as variations in electric current. The shadow of the moving fingers, now in the form of varying electric current, was fed into the radio transmitting set and handled in exactly the same way as hundreds of jazz concerts are broadcast every night.

The receiving antenna in the case of this demonstration was only a few feet away from the sending antenna on the roof of the Jenkins laboratory, but for a short distance that wave of a hand went through the ether in the form of radio waves. After being picked up by the receiving radio set, these impulses were changed back into an electric current and sent to the radio-vision receiving set.

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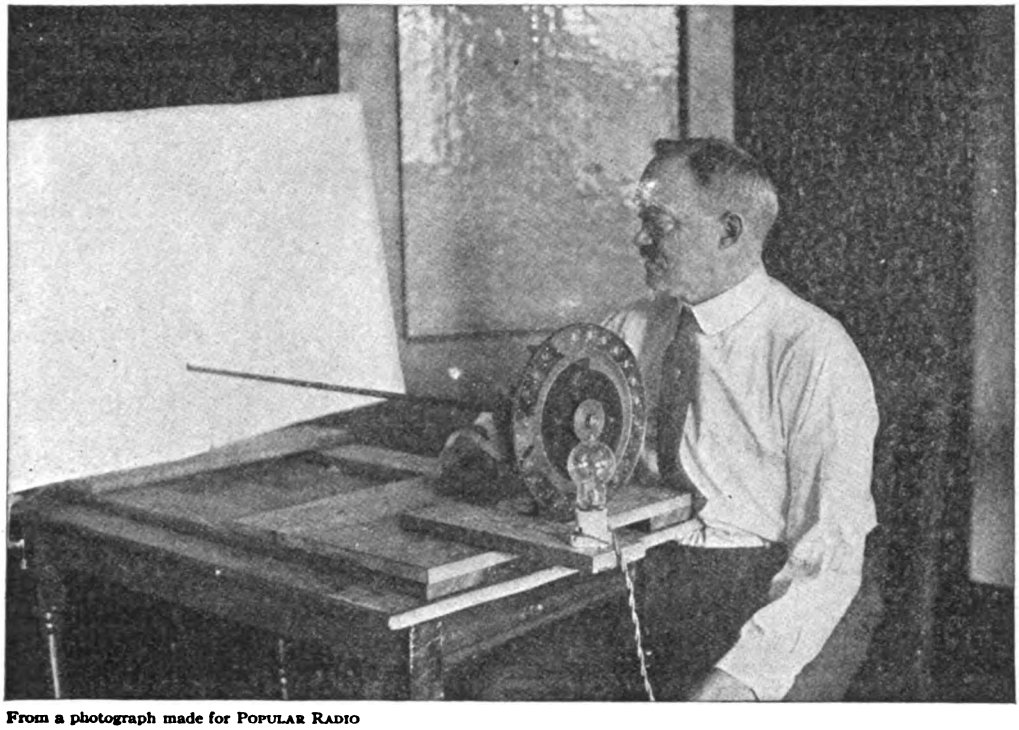

From a photograph made for POPULAR RADIO

THE ESSENTIALS OF THE RECEIVING SET FOR RADIO VISION

The lamp shown in the picture receives a varying electric current and transforms it into variations in light, which are taken by the multiple-lens disk and thrown onto the screen in the background in the form of a picture. The motor driving the disk is located behind the screen.

This receiving apparatus consisted of just four essentials: a lamp that changed electric-current variations into light variations, a whirling disk similar to the one in the transmitter, a lens, and a picture-receiving screen.

Radio vision is as much a matter of optics as electricity, and since light and electricity are both members of the big family of ether waves, differing only in length, there is no reason why they should not work amicably.

Yet there is no question but that the radio part of radio vision plays second fiddle to the whirling disk. These rings of lenses make radio vision possible. They take the wave of the hand and impress it portion by portion on the light-sensitive cell; they take the rapidly fluctuating light and change it into a moving picture.

The human eye is easily pleased and slurs over minute imperfections. All of the halftone illustrations in our newspapers are nothing but areas of coarse dots, sixty to the inch, that our eyes obligingly turn into pleasing pictures. That is a very useful optical trick and it is used by Mr. Jenkins in sending still pictures by radio and also in his process of radio vision.

Again, speed can be used to fool the eye. Getting fooled is not always unpleasant, because it allows us to enjoy motion pictures. In the theaters, sixteen photographs appear on the screen each second, and that is speedy enough to make it seem to our eyes that the motion is in the objects in the pictures, not in the pictures themselves. And this optical illusion is used by Mr. Jenkins in radio vision.

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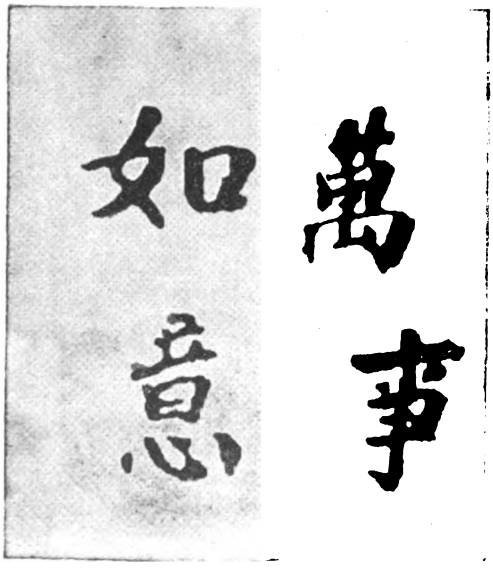
Lines, not dots as in the halftone, very close together, are the structure of both pictures and vision by radio. These lines of light are swept across the progressing picture by the whirling disks. Light is the paint and the whirling disk is the brush in radio pictures and vision.

In the Jenkins apparatus for transmitting still pictures, the whirling disk has a prism curled around its circumference. Prismatic lenses, as almost all of us have observed, have a way of persuading light to deviate from its straight path. The disks used in transmitting still pictures by radio are made entirely of glass, and the prismatic lens is ground on the circumference. This is, however, the equivalent of many lenses since it is of varying thickness. And this causes a beam of light, projected through it while it revolves, to be swept from one side to the other or up and down.

Two of these disks are used to project the photograph upon the transmitting light-sensitive cell in Jenkins' pictures by radio apparatus. One disk covers the picture in one direction while the other covers it at right angles to the first, and one of these disks operates many times faster than the other so that the effect, in both sending and receiving, is the drawing of lines across the picture very close to each other. In sending still pictures, this operation takes about a minute.

To transmit motion, the sending must be speeded up so that at least sixteen pictures are transmitted each second instead of one picture in several minutes. Compared with this, ordinary motion pictures such as we see in theaters, are comparatively simple. At the movies whole photographs are projected on the screen all at once, and they are thrown on and taken off so rapidly that the eye can not detect the separate projections but blends them together into continuous motion of the objects in the picture. In radio vision the picture is projected on the screen portion by portion, but to produce the effect of motion or actual vision a complete picture must be built



AS IT WAS SENT—

This is the original Chinese message that was handed to the radio operator for transmission at the sending station. Its Chinese significance is "Ten thousand joys on your journey."

—AND AS IT WAS RECEIVED

This is the message as it was received by the radio operator and handed to its Chinese addressee; it is practically a perfect reproduction in somewhat grayer tone.

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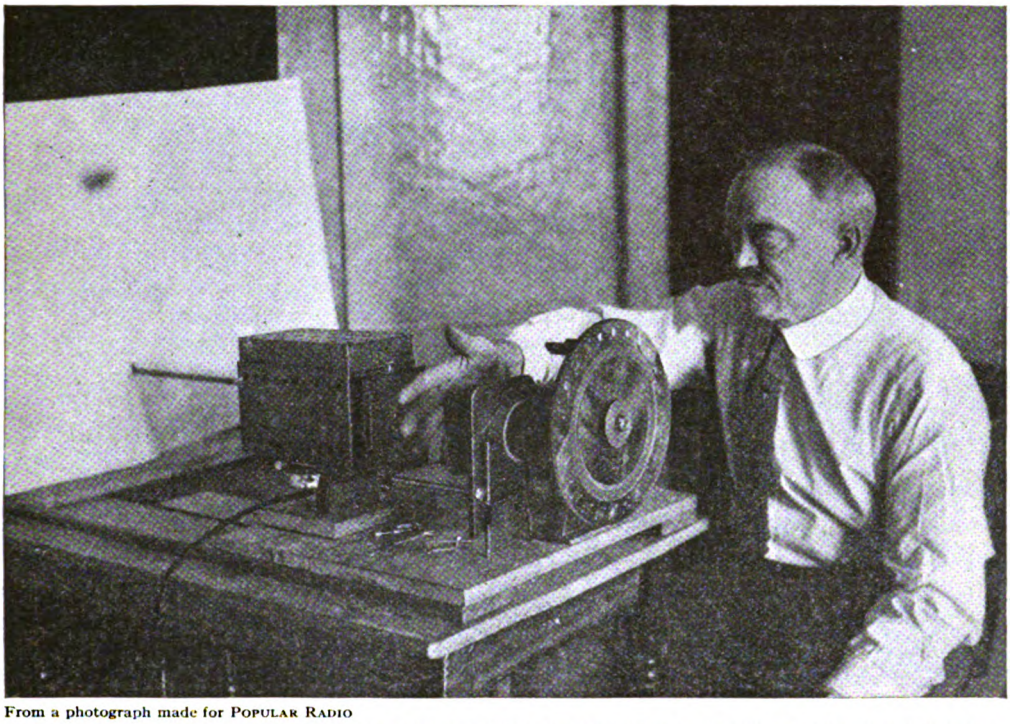

From a photograph made for POPULAR RADIO

THE SIMPLE APPARATUS THAT SENDS A WAVE OF THE HAND BY RADIO

The inventor, C. Francis Jenkins, is placing his hand in the stereopticon which throws a beam of light on the multiple-lens disk. This disk impresses a picture of his hand upon the light-sensitive cell (which is across the room and not shown in the photograph) and this cell translates variations in light to variations in electricity.

up every sixteenth of a second. Prismatic disks that produce only one picture a minute are obviously too slow.

So Mr. Jenkins has devised a new form or disk, that contains lenses that combine the function of covering the picture vertically and horizontally. In the apparatus that he demonstrated, the disk was so made as to produce one complete picture with each revolution. It contained forty-eight lenses in all. Each of these was, in effect, a combination of a rather flat convex lens and a prismatic lens. The lenses varied by having the prismatic part thick on one edge for the first lens and then gradually changing their angles until the thickness was on the other edge for the last or forty-eighth lens. For all lenses the convex portion was the same. Thus in this compound lens both horizontal and vertical motion of the light was obtained. The forty-eight lenses forming a prism of varying angles shifted the scene once horizontally, while each convex lens by its vertical motion swept the scene over the light-sensitive cell in one-forty-eighth the time of the horizontal shift. Thus each scene was impressed on the cell as forty-eight horizontal lines spaced close together. The speed necessary for the production of continuous motion in the radio-vision receiving apparatus was sixteen revolutions a second or 960 r.p.m.

Exactly the reverse process takes place in the radio-vision receiver. The dismembered scene enters the lamp of the receiver as a fluctuating current, strong where the light of the transmitted scene was strong, weak where it was weak. Faithfully the lamp repro-

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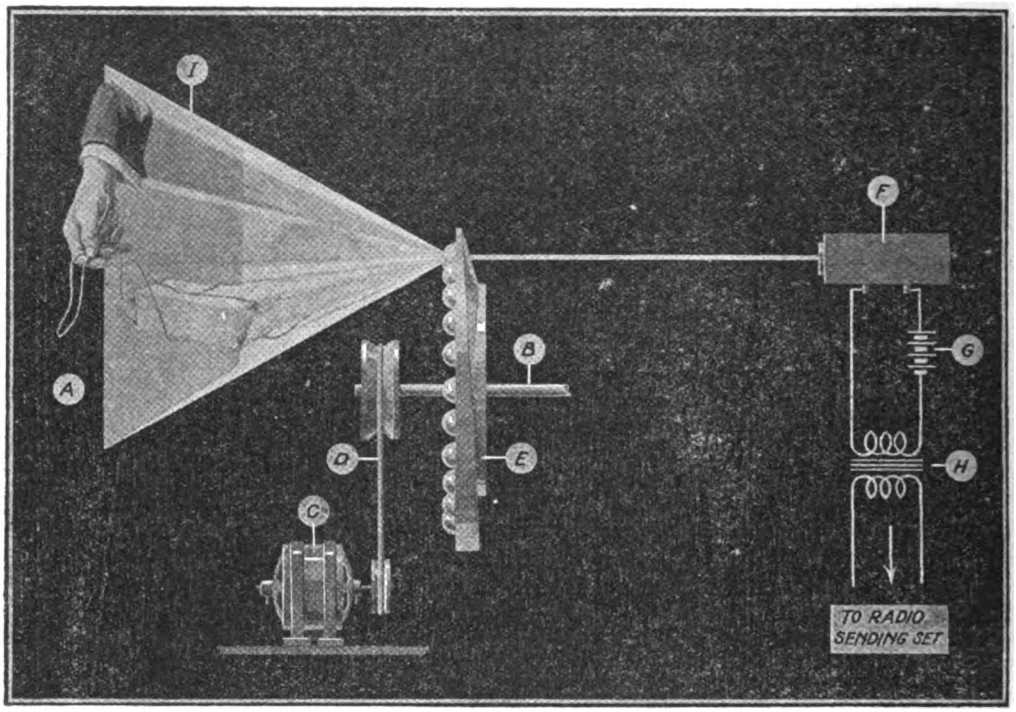

From a drawing by J. H. Picken for POPULAR RADIO

THE RADIO TRANSMITTER FOR MOTION PICTURES

The light I, from an object A, is focussed one strip at a time, through lenses on the rotating disk E, onto the light-sensitive cell F. Electric current from the battery G, is modulated by the light and sent out by radio in the usual way.

duces light, and the whirling disk with its dual-purpose lenses sweeps the scene on the screen just as its twin in the transmitter swept it on the light-sensitive cell.

It is a shadowy wave of the hand or movement of the fingers that is produced. A picture composed of only a few horizontal lines, varying in light intensity along their lengths, can not be expected to be very distinct or detailed.

But even shadowy motion such as was produced was a demonstration of the important possibilities that the method holds. Increase the number of lenses that produce each picture to several hundred and the detail will come.

In another important way, the radio-vision apparatus differs from the radio-pictures outfit. The light source in the receiver must vary quickly with variations in the incoming current. The ordinary lamp that is speedy enough for still pictures by radio can not make the pace necessary for radio vision. Mr. Jenkins is using a corona glow lamp, in which the gas around the internal electrodes gives off the light. The lamps are filled with neon, one of the rare inert gases. With this kind of lamp the lag is sufficiently small but the intensity of light is not great and efforts are being made to obtain lamps of the same principle that are more suitable.

The question of synchronism, of keeping the disks of the transmitting and receiving sets running exactly together, Mr. Jenkins says, is a simpler problem in radio vision than in radio transmission of pictures. The pulleys used are conical and the speed of the

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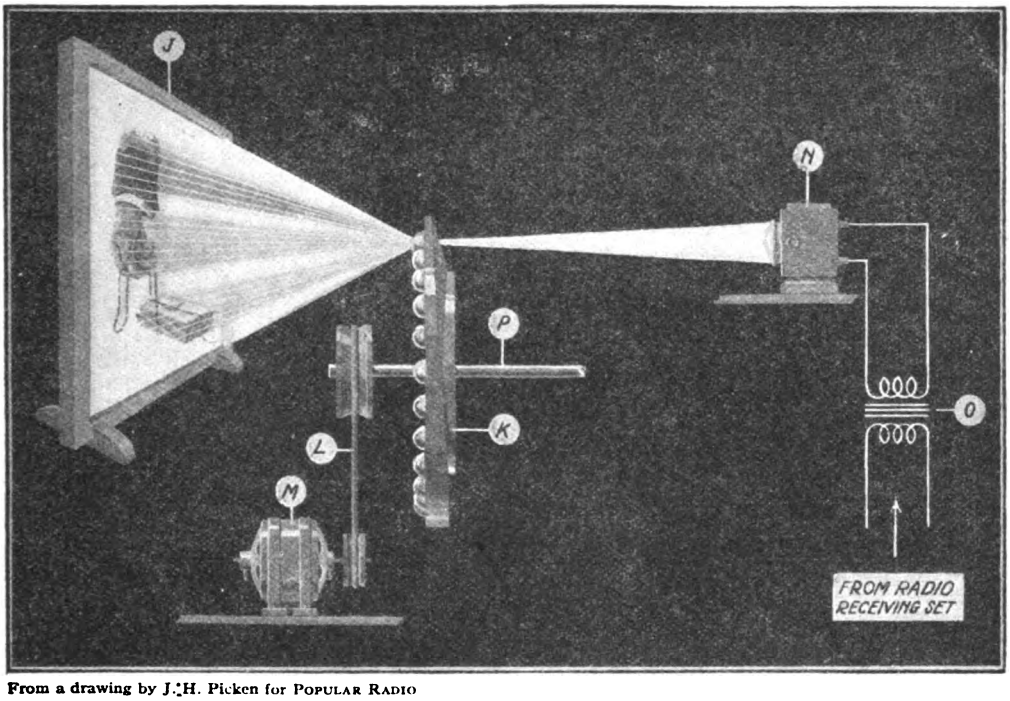

From a drawing by J. H. Picken for POPULAR RADIO

HOW THE RADIO MOVIES ARE RECEIVED

Radio impulses are communicated through the transformer O, to the device N, which reconverts them into pulses of light. These pulses, passing through the lenses on the rotating disk K, produce an image of the original object on the screen J.

disks can be regulated by sliding the belt slightly to such a degree that synchronism can be obtained more easily than the picture is framed in ordinary motion-picture projection today. In the experimental set that was demonstrated, disks of both the transmitting and receiving sets were driven from the same motor for the sake of simplicity in operation.

The transmission of pantomime by radio has been accomplished. There is no reason why the receiver should not have been in New York rather than in Washington next to the radio-vision transmitting set.

The perfection of the invention has not yet reached the point where actual scenes in all their lights and shadows can be reproduced or motion pictures distributed to the hearth and home. But the experimental apparatus devised by Mr. Jenkins gives promise eventually of our being able to see in New York at nine o'clock in the morning what "will occur" the same afternoon at two o'clock in London.

Mr. Jenkins simply moved his hand and fingers when he made his demonstration. With those moving shadows radioed on the screen, I could hardly refrain from hoping that he would form a shadowy rabbit or bird with a long neck or some other strange animal such as all of us have made or seen for the amusement of children. Tony Sarg and his marionettes might well produce pantomime by radio vision when the process is slightly perfected.

In fact, it is a hope of Mr. Jenkins that he will be able to devise a low-priced piece of apparatus that will take pantomime entertainment into the home just as bedtime radio stories now are received with so much glee by eager childish ears.

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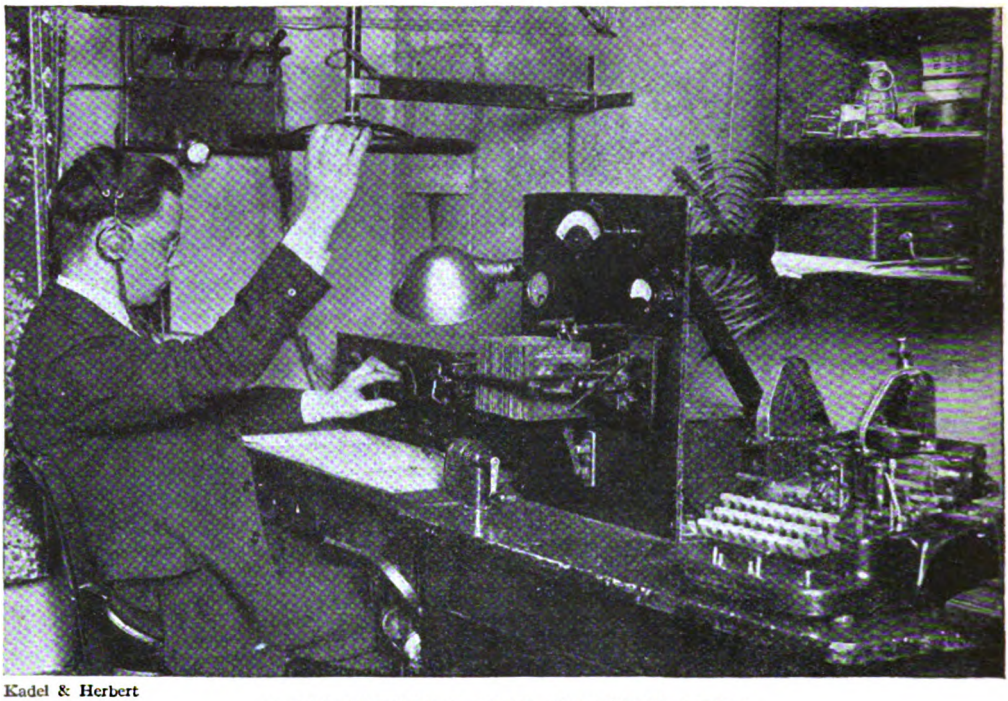

Kadel & Herbert

A YOUTHFUL RADIO AMATEUR WHO SERVED HIS COUNTRY IN WARTIME

Wendell Kilmer, whose station 2KX is known to amateurs in the east, rode his hobby to such good effect while the German-owned station at Sayville, Long Island, New York, was in operation that he was given special permission to operate during the war period.

HOW RADIO IS MAKING THE AMERICAN BOY

"A Citizen of the World"

During a recent conversation, Forrest Crissey, the well-known author, told the incident that first awoke him to a realization of the tremendous effect that radio is having upon civilization. The incident was so interesting—and so significant—that the Editor asked Mr. Crissey to tell the story to the readers of POPULAR RADIO. This is it.

ALTHOUGH I am not of those who find themselves and their own thoughts intolerable company—for a day or even an hour—I suffered a sense of well-nigh sickening loneliness as I climbed a series of richly wooded hills in "Old Chautauqua" County to spend a night with a boyhood friend.

"What a desolate place," was my inward exclamation, "in which to rear a family of children!" The wood-colored house stood on a side hill and was almost encircled by dense woods of hard maple, beech, birch and hemlock—huge and towering trees typical of New York State.

Before I followed the lane leading from the main road to my destination my thoughts went back to my own boyhood in that same county—but on a farm far more open and friendly, and much less remote from neighbors—and I recalled, as distinctly as I smelled the moist, woodsey odor of the forest

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through which the lane wound, the feeling of complete isolation which often assailed me as a child on the little farm in the snug and verdant Bear Creek Valley. How easy it had been, then, to imagine myself a Robinson Crusoe cut off from all contact or communication with the great world of busy, happy human beings who did not know solitude, isolation, loneliness.

This recollection was so vivid, so compelling, that I sat on a moss-grown boulder to give a few minutes of pity to the small boy who had felt so much alone, so wholly separated from the great world outside Bear Creek Valley, in the years of my country childhood. Instantly I was drawn into a survey, an inventory, of my contacts with "the world without." Of a truth they were pitifully meager: the regular Sabbath pilgrimage to the little white church in the village of Stockton. If a returned missionary, intent on drawing a few dollars from the congregation, was permitted to occupy the pulpit and relate harrowing experiences among benighted and bloodthirsty savages of remote and heathen lands—the occasion was never to be forgotten.

Then there were the visits to our home of a friend of my father's from Ohio, who told thrilling experiences of his life in the south after the Civil War—and smoked fragrant cigars in the sacred "front parlor" as he related his "Carpet Bagger" narratives. Here was a Man Among Men, a Citizen of the World! From my slippery perch on the haircloth stool beside the marble-topped center table I hung on his words with avid and thirsty delight.

Then there were the annual visits of the itinerant craftsmen and peddlers —a hunched old "infidel" tinker who carried his tools in a tin box slung from a shoulder strap; a swarthy essence vender, reputed to be "part Indian" who carried his aromatic distillations in brown jugs and applied his art of salesmanship by touching the tip of my tongue with the small end of each cork; a sleek, perfumed "watch peddler" who carried cases of marvelous pocket timepieces, pillowed against dainty satin; and a glib and merry Irish vender of linens and laces. These exciting visits were, in the main, my world contacts.

As I sat on the moss-grown rock taking stock of the limitations of my

Keystone

A HOME-MADE SET AND ITS BUILDER

A representative of the great army of young American radio fans—in this specific instance Master Joseph S. Frelinghuysen, Jr., the son of Senator Frelinghuysen of New Jersey.

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boyhood—before pushing on to the end of the land to pay my old friend a surprise visit—I felt a wave of pity for the loneliness of his boy, more completely shut away from companions and a wholesome and cheering contact with the world of affairs than I had ever been down in the valley where neighbors were nearer. Yes; if opportunity opened, I would point out to Tom the injustice which he was doing his alert young lad by isolating him on this remote, timber-walled hill farm. There was a message for that father—and he would get it if he gave me half a chance!

The boy didn't appear until dinner was on the table. My eyes instantly searched his face for tell-tale signs of his loneliness. They were not in evidence. Instead he seemed strangely at ease, wholesome, natural, happy. The shy wistfulness of the isolated and the lonely was utterly lacking in his eyes. Instead they seemed to carry the hint of an eager surprise held in abeyance with some difficulty. Occasionally he exchanged glances with his mother which seemed to say:

"Aren't we going to show this friend of father's a thing or two? We'll open his eyes!"

Then the solution of the mystery came to me: After supper he was going to bring out the family checker-board and "stump" the visiting stranger to a game. This inspiration brought back to me the marvelous relief to evening monotony which came with the first checker-board that had cheered our home. And how I hated checkers now! But I would have to make the best of the ordeal for the sake of good-fellowship to the lonely and isolated young son of my host.

As we arose from the table the boy winked at his mother and, with rather well-supressed eagerness asked:

"Like music?"

Being morally certain, from casual inspection of the family living room and the parlor, that the roof did not cover a talking machine or piano, I recalled my own boyish experiments with the harmonica—and feared for the worst! What an instrument of family torture that shining rectangle of cells had been in my lips!

I think the boy must have sensed something of my fears for a half-amused grin overspread his face as he opened the door into the traditional "downstairs bedroom" and invited me to be seated in the Boston rocker which I recalled as my favorite resting place in his grandmother's sitting room.

As he drew a dark cover from a wall table and revealed a radio set of impressive proportions I was stunned into silence.

The boy's tongue was loosened and he became an easy, well-poised master-of-ceremonies, remarking:

"I put all the money I earned in grapes, over Brockton way, into this set. Cost quite a lot, but it's worth it. I can pick up Los Angeles, when conditions are good—had Chicago last night clear as a bell. Well; I'll tune up and see what we can get."

As his deft hands flashed from one tuning device to another his mother whispered:

"He'd rather stay at home and work that thing than go to a party or a picture show in town. Can't drag him away. And before he had his first little set he was wild to go out—said it was as lonesome as a graveyard up here away from everybody and everything." She hesitated a moment and then confessed: "He was getting to be rather a problem and we were anxious. But that's all past now. He's changed a lot, too, since he took hold of radio—developed! I can see that he's getting an education in ways and things that would have been beyond him if he hadn't become so carried away with this. I don't mean in electricity or mechanics or whatever it is that he's forever studying into in the

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YOUNG AMERICA LISTENS IN ON THE WORLD

No longer are the affairs of men as a closed book to the American boy; they are matters that are brought close to him by the magic of radio. And their personalities and their problems are becoming known to the younger generation in a way that was never before possible.

magazine which he takes and the books which he buys; I mean in the things which he hears over the radio.

"Why, the other day we heard President Harding speak just as plainly as if he'd been in this house. The next day Junior talked about what Mr. Harding had said in a way that showed me how the President's message had sunk in. He wouldn't have read it in a newspaper—but he took it in over the wireless. It's the same way with music, he—"

"Here's KDKA," interrupted the boy. "Generally have good concerts at Pittsburgh—real artists, not the jazz stuff. Like a little jazz now'n then, but—"

A clear soprano cut in—for the boy's set boasted an excellent amplifier—and not a word was spoken in the room until the last silver note trailed into silence.

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Harris & Ewing

A BOY'S TRANSMITTER THAT WAS HEARD IN SWITZERLAND

Station 3ZH, located in Washington, D. C., is operated by the youthful Herbert Hoover, Jr., who is making a name for himself quite independently of his famous father.

"Now," eagerly exclaimed the lad, "I'm going to try for Los Angeles. Like t' show you what this set 'll do. If it was a clear, still winter night I'd be almost certain of tuning in on any station in the east—but you never can tell in other seasons."

We waited with a breathless expectancy that amounted almost to suspended animation while the boy deftly adjusted his instrument. One moment he shook his head as if in despair, then suddenly thrilled with recovered hope—reaching out across the old Western Reserve, the Mississippi Valley, the Great American Desert, the Rockies and the plains and valleys of California for the sound of a voice in the City of the Angels which the old missionaries had established so many, many years ago! And the boy turned a face shining with triumph upon us as the strains of Chopin's *Moonlight Sonata* became audible—distinct, silvery and yet carrying in its delicate attenuation a hint of the far sweeps of mountains, plains, deserts and fertile lands between the player and her four auditors in the remote, isolated hillside farm house in Old Chautauqua.

Isolated? The boy's eyes lighted with faith and prophesy and he forgot his youth and our maturity as he exclaimed:

"Some day I'll pick up London and Paris just as we have Los Angeles—and that's coming soon, too. Just think of our hearing the Premier of Great Britain speaking to a London audience or a grand opera star singing in Berlin—hearing it right here in our own farmhouse a few miles from the shores of Lake Erie! I'm going to have the outfit that'll do it, no matter what it costs. It's so, so—well, gee! I've just got to, that's all!"

"Yes," I responded, "I think you're right!"

Then I laughed and related my reflections as I had sat on the big stone half way up the lane—my memories of the isolation and loneliness of my own childhood, in the little valley a few miles below, my pity for young Tom.

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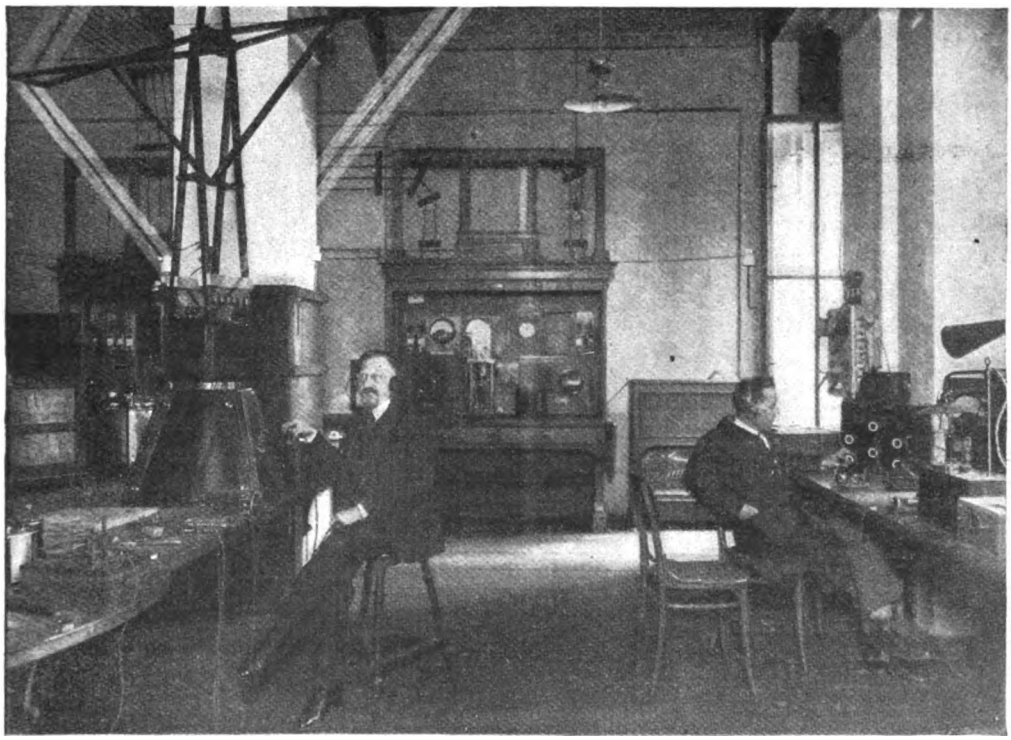
"And," I added "you and your radio have opened my eyes to the fact that you are a Citizen of the World compared with the boy I remember. You are ages older, wiser and more alive than that Crusoe-like youngster. Theoretically I have known that the radio is a marvelous thing, a great, vibrant, vital and distance-annihilating thing. But its reach into the realm of boyhood never occurred to me until tonight. I shall always count this as one of the most revealing experiences of my life. It has given me a new definition of radio. The voice that can reach and dispel the isolation of the boys in the remote homes of American farms and ranches is certainly the voice of a new Evangel that can not be stilled."

"You bet," was the boy's enthusiastic response. "Why; it makes me interested in almost everything, everywhere. I read up a lot about what I hear by the radio. Just do it because I want to—not because anyone tells me to. I get interested in a lot of things and follow 'em up in my reading. If I had to choose between going to college and giving up my radio—pushing ahead with it as fast as it's developed by the big men who are working in it—I think I'd stick with the radio."

And my reply to his unaffected fervor was:

"I'm not so sure but that you are right."



From a photograph loaned by Armstrong Perry

THE EXPERIMENTAL LABORATORY IN AUSTRIA'S RADIO SCHOOL

The loop aerial (at the left) was built under the direction of Dr. Max Reithoffer, who appears in the picture. The loop has a tuning range of 7,500-15,000 meters. At the right is an assistant who is bringing in radiophone stock-market reports from Berlin, with the aid of an outside aerial, four stages of radio-frequency amplification, detector, two stages of audio frequency and a loudspeaker.

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From a photograph made for POPULAR RADIO

How to Select
YOUR RADIO PARTS

Have you ever been undecided whether to buy an instrument for your set at $2.50 or $5.00? Have you ever bought a condenser because it "didn't cost as much" and have the plates loosen up so that you could not make a proper adjustment? Have you ever bought paper condensers when you should have bought mica ones, or vice-versa? In other words, do you REALLY know how to choose the parts for your radio set? This article tells you how.

By S. GORDON TAYLOR

I HAPPENED to be at a friend's house the other day when his fourteen-year-old youngster came in with a big package of parts that he had just purchased in a downtown radio store. He had been hoarding his money for months until he had saved enough to purchase parts to build a set that would enable him to "pick up Pittsburgh and Chicago." At last he had accumulated the required sum and here he was, all ready to start assembling the receiving set of his dreams.

He spread out his purchases on the table with the air of a world conqueror, but the exhibition was pathetic. The collection of junk he had brought home was almost valueless to a radio circuit. He would probably develop gray hair long before he succeeded in getting his set into working order.

He had figured on paying a reasonable price for his parts but when he looked around in the stores he found many parts could be obtained for prices considerably lower than he had figured. He immediately began to picture his set with one stage of amplification and in order to make his money cover this added list of parts he had purchased the cheapest of everything.

Had this beginner gone ahead to make his set of these parts it is doubtful whether he would have obtained even fair results. His father came to the rescue, however, and saved the day by supplying enough cash to enable the boy to exchange his junk for some really usable parts.

Usually, however, the novice who

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gets "stuck" does not get off so easily. The moral is plain. Anyone who buys radio parts or sets will do well to call on a friend who really knows something about the points to look for in selecting instruments.

Unfortunately every beginner does not have among his friends an experienced fan who can help him. For them the following suggestions will prove helpful:

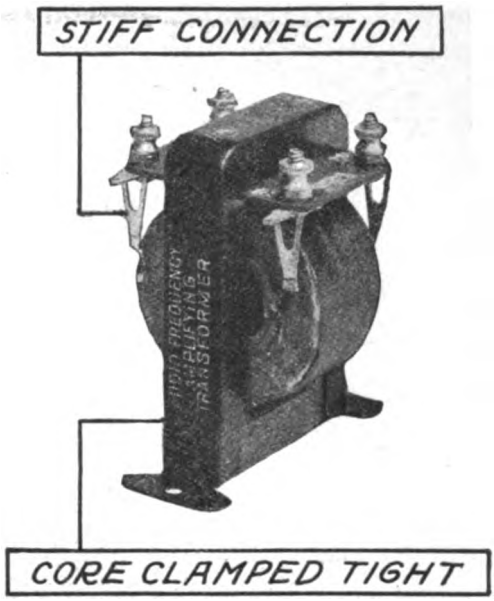
In the first place, all cheap instruments are not bad nor are all expensive ones good.

As a general rule it pays to buy the best one can afford. The very cheap articles should be avoided by all means. It is usually a safe rule to make a practice of paying a little more than the medium price. For instance, an article may run anywhere from $1.00 to $5.00 in price, according to the make. In such a case a price of $3.00 to $4.00 will usually assure good quality.

When selecting a part see that all contacts on the apparatus are well made and positive in their operation. In some variable condensers and variometers, for instance, electric contact is made by means of a shaft rubbing against the bearings. Frequently such a contact is *not* positive. A direct flexible wire connection is to be preferred. This is called a "pigtail" connection and is made by connecting a wire or coil-spring between the shaft and bearing in such a way that the shaft can turn freely but still maintain a positive path for the current whether or not there is a good contact between the shaft and bearing.

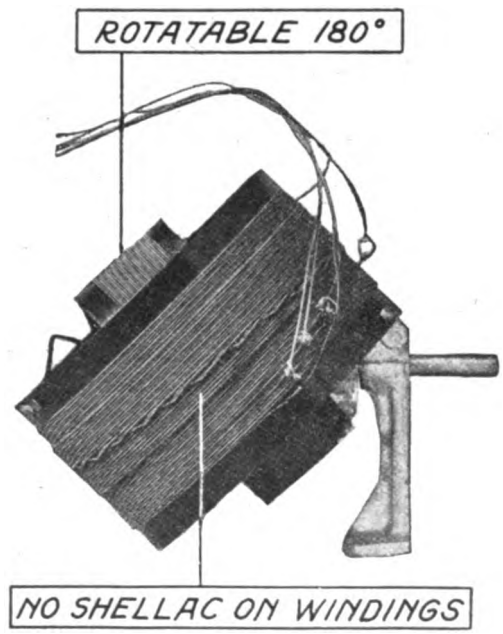
Here are some points to watch out for in purchasing individual instruments. For the sake of convenience the items have been arranged in alphabetical order:

ANTENNA WIRE—For the average antenna the regular seven-strand copper antenna wire is excellent. Single-strand copper wire will give good results, but it is not quite as strong as the seven-



AUDIO-FREQUENCY TRANSFORMER

Be sure that the wires running to the terminals are protected. The core laminations should be clamped tightly together to prevent vibration on loud signals.



VARIOCOUPLER

A finer tuning is assured with a variocoupler which is rotatable throughout 180 degrees. The windings should be wound dry.

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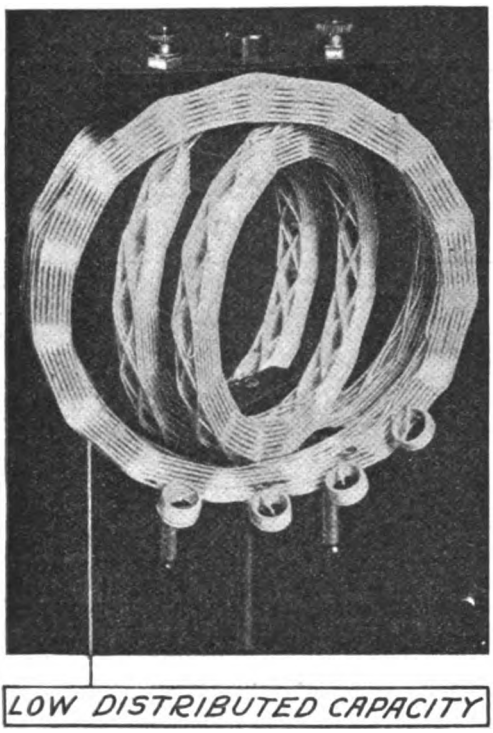

VARIOCOUPLER

A new type of winding which reduces distributed capacity to a minimum.

strand wire nor does it give quite as loud a signal, although this latter point is almost negligible.

ANTENNA INSULATOR—Regular porcelain cleats are inexpensive and serve the purpose as well as anything for receiving. If composition insulators are used, buy the best, because some of the cheaper ones have a tendency to allow the end rings, through which the wire is passed, to pull out, thus causing the antenna to fall—a most exasperating occurrence, to say the least. If porcelain cleats are used be sure that they are glazed, otherwise their insulating qualities are affected by the absorption of moisture.

BATTERIES—When buying batteries the safest guide is the price. In almost every case the battery will be sealed or so inclosed that the inside cannot be seen, whether it be storage, dry-cell or "B" battery. Everyone is too familiar with the ordinary dry cells (such as are used to operate the WD-11 tube) to need any instruction on this point. In the case of storage batteries it is well to stick to recognized makes. They may cost more but they have "quality"; that is why they are well known. Storage batteries such as are used for the lighting systems on automobiles are good for radio work. Most manufacturers of storage batteries make a special type for radio and those are the best to buy. The size of the storage battery is an important consideration, as one will realize after he has carried one two or three blocks to have it charged. If one must depend on a charging station to charge his battery then a small one rated at 40 to 60 ampere-hours is best. It will be necessary to have it recharged more often than the larger batteries but it is light enough in weight to be carried conveniently. If more than one vacuum tube is to be used, however, a larger battery of from 60 to 120-ampere hours is to be preferred. In such a case a battery charger will be needed so that the charging can be done at home from the electric light circuit.

Most of the "B" batteries on the market are good, with the exception of the very cheapest. Here again those recognized as best for radio work are those manufactured by well-known companies. Batteries of 22½ volts come in two sizes; small, and large. So do the 45-volt batteries. In either case it is best to buy the large size as they will last much longer than the small size, and in the end will be found cheaper. For use with detector tubes buy 22½-volt batteries. For amplifier tubes two or more 22½-volt batteries, connected in series, may be used, but the 45-volt battery is to be preferred as a matter of convenience.

CONDENSERS (FIXED)—Buy the best. Avoid the paper-covered variety. Often

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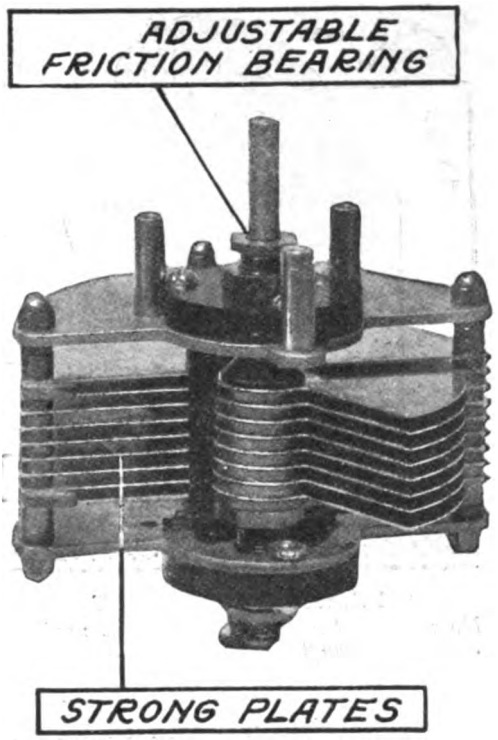
the contacts are poor and they are loosely assembled as a rule The better kind are assembled under heavy pressure and this pressure is maintained by means of a metal case or by impregnating with wax so that a solid block is formed. Condensers are rated in microfarads and one should be sure to obtain the proper capacity for the particular use to which the condenser is to be put. In most circuit diagrams the capacities of the condensers used are specified. In cases where they are not, the phone condenser is usually .001 microfarads and the grid condenser either .00025 or .0005 mfd. If a tubular grid leak is to be used in shunt with the grid condenser, a special condenser may be obtained with clips all ready to mount the grid leak. The better grade condensers, mentioned above, have a mica dielectric which is much better than the oiled paper used in the cheaper grades.



VARIABLE CONDENSER

The plates should be cut out of heavy, flat, rigid material to prevent warping. One good point is an adjustable split-collar friction bearing.

CONDENSERS (VARIABLE)—These condensers are a vital part of any radio set; it may truly be said that a set is only as good as the condensers that are used in it. Do not buy a cheap one because it will cause no end of trouble. First of all see that the moving plates do not touch the stationary ones as they revolve. The moving and fixed plates should remain equally spaced throughout the complete revolution. One glance is usually sufficient to enable even the beginner to tell a good condenser when he sees it because its mechanical perfection will be at once noticeable. It almost always follows that if a manufacturer makes a mechanically good condenser it will be good from the electrical standpoint also. Pigtail connection between shaft and bearings, as previously described, are not essential but are an advantage. Large plates of very thin metal are considered less desirable than thicker plates of smaller diameter and the smaller condenser takes up less panel space. End plates of bakelite are suitable or hard rubber plates are equally good, provided they are not less than ¼-inch thick so they will not bend under the pressure to which they are subjected by the tension of contact between shaft and bearing. Some condensers have end plates of cast aluminum. These are good and have the advantage of rigidity and lightness. Iron ends should be avoided. These will be found on some of the cheaper makes. 43-plate condensers have a capacity of approximately .001 mfd. and the 23-plate variety are of about .0005 mfd. For condensers which are used in a circuit that is critical in adjustment, as the average secondary circuit, or the primary condenser in a single-circuit set, a condenser with a vernier attachment is useful. The vernier may take several forms but the type I have found most satisfactory is the one consisting of

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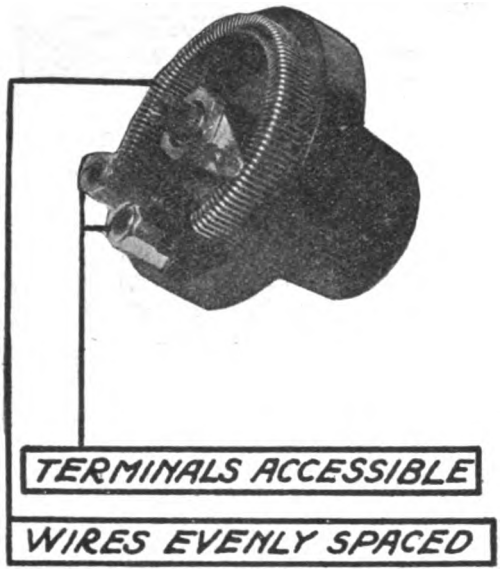

FILAMENT RHEOSTAT

No matter what type of rheostat is used, the terminals should be accessible to facilitate connection.

three extra plates mounted on the end of a regular condenser. This is really another variable condenser mounted right on the large one but it gives much finer tuning than the larger one.

GRID LEAKS—A grid leak may easily be made in a few minutes with a piece of fiber, two binding posts and a few pencil lines. The one objection to this type is that it may be affected by dampness or weather conditions or even by dust. On the other hand it has the advantage of being adjustable, the adjustment being made by simply adding or erasing some of the pencil marks. For ordinary use, however, the grid leak value is not critical, so this feature is not really important. In purchasing grid leaks the glass-tube variety is probably best. Usually a leak of about two megohms is the proper size but good results are often obtained with 1 or 1½ megohms.

HONEYCOMB OR DUOLATERAL COILS—There are few brands on the market and these are practically standardized, both in price and quality. Care should be exercised in selecting a mounting. One which has calibrated coupling dials is to be preferred because then a notation can be made of the setting at which a certain broadcasting station can be best received and when it is desired to tune in the same station again the setting can be duplicated by referring to the notations. A useful refinement is the mounting which has extension handles. These make extremely fine tuning possible.

JACKS—Buy good ones and inspect them closely as even the best seem to have a tendency to be imperfect. First, look at the contacts carefully in the case of double-circuit jacks, to see that there is a good contact between the arms of the different circuits when the plug is or is not inserted. Make sure that the jack will fit the plug you intend using. Next, see that the screw which is used for mounting the jack on the panel will screw far enough into the frame of the jack to grip the panel tightly. If a 3/16-inch panel is used it will be found that most jacks will require an extra washer which the dealer will usually furnish. A jack that is imperfect can cause a great deal of trouble and one cannot be too careful.

LIGHTNING ARRESTERS—Insurance regulations require lightning arresters on every outdoor antenna and they further specify that only those approved by the Board of Fire Underwriters are acceptable. Therefore, purchase an approved type which bears the approval stamp of the board. There are two general types—those for outside mounting and the indoor type. It is advisable to use the outdoor type because in some suburban communities the insurance companies will not accept those mounted indoors, even though of a type approved by the underwriters.

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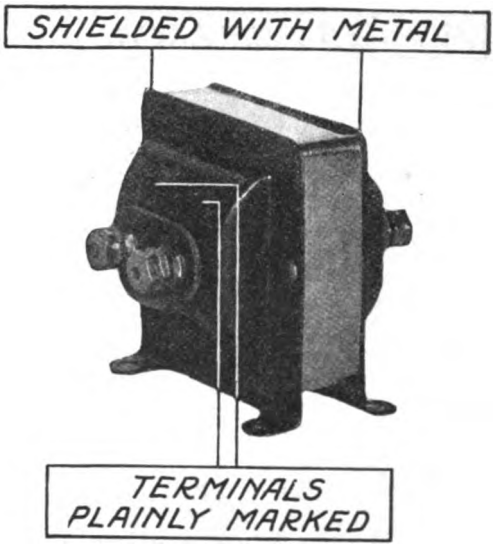
PANELS—Many kinds of compositions are used in making panels. It is best to stick to well-known, standard materials, however, for then you will know what you are getting. Resinous compounds or hard rubber are perhaps the most commonly used. Hard rubber serves very well if it is screwed on the front of a cabinet to keep it from warping. If a cabinet is not used it may be reinforced with metal strips. Quarter-inch hard rubber will not usually warp unless very large panels are used. If a resinous compound is used the thickness need not be greater than 3/16 of an inch. Wood may be used for panels provided it is well seasoned. A three-ply veneer which has been given three coats of good white shellac makes a good panel and is somewhat cheaper than hard rubber and considerably cheaper than good grade compositions. Hard rubber is very easy to drill but in the case of compositions more care must be exercised to keep them from chipping where the drill passes through the back. Ordinary red or black fiber should be avoided because it warps badly unless strongly reinforced, and will absorb moisture.

PHONES—Headphones are an article that cannot be judged by appearance. Nor can they be judged by price entirely. *The rating in ohms means little,* as practically all phones used for radio work are rated at from 2,000 to 3,000 ohms a pair, whether they be good, bad or indifferent. A good pair may be purchased at present day prices for five or six dollars. They may not be the best but they will serve admirably for ordinary use. If phones are to be used on a horn with one or two stages of amplification, then a better grade phone with mica diaphragms should be used because the metal diaphragms in cheaper phones sometimes rattle against the magnets causing a "tinny" noise which is unpleasant especially if there is a large volume of sound. In buying phones pick out a time when the dealer is not very busy and have him try out the different kinds on a receiving set and compare their volume and clearness. When you decide on a pair be sure that the two phones are well matched as to tone and volume—*test them both out on the same ear!*



AUDIO-FREQUENCY TRANSFORMER

A metal shield around the windings protects them mechanically and electrically. The terminals should be clearly marked for identification in connecting up.

PLUGS—Most of the plugs on the market are good; the difference in price is largely dependent on quality of workmanship. Selection is, therefore, a matter of personal preference as to shape and other details. Be sure that the means of gripping the receiver tips is secure and that the plug fits the jack in which it is to be used. I prefer the round type myself, because they may be changed from one pair of phones to another without the necessity of removing screws to take the plug apart.

RHEOSTATS—Many of the cheaper grades work very well. The contact arm should slide easily over the coil

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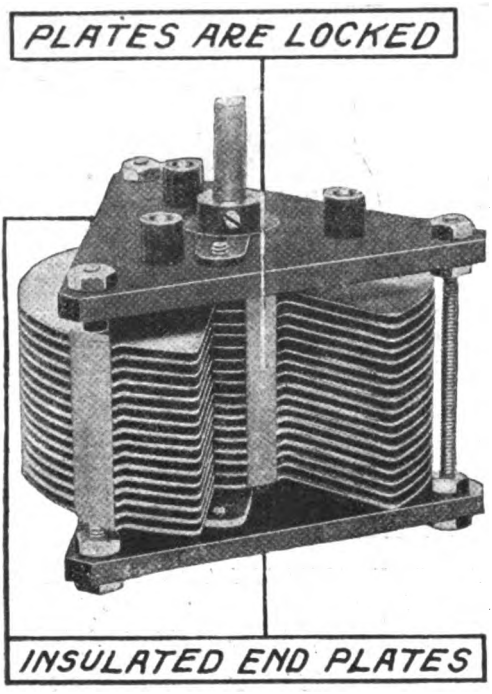

VARIABLE CONDENSER

A new method is to lock the plates together in a slotted strip of metal to prevent shifting. Wide spacing is obtained by using insulated end plates.

of resistance wire but should at the same time make good contact. Some rheostats make good contact at some points but poor at others. In buying one, turn the arm, and see that the pressure is equal in all positions A vernier rheostat is not necessary with amplifier tubes. With the UV-200 and other detector tubes a vernier *is* needed. For such tubes a good rheostat is the type which functions by increasing or decreasing pressure on carbon disks. In this type no resistance wire is used and extremely fine regulation of current is possible.

SOCKETS—All sockets are alike, the main differences being in the material used in the contact springs and the insulating material used in the base. Test the contact springs to see that they are springy, but fairly stiff, so that they will press tightly against the prongs on the tube when it is inserted. It is difficult to judge the material in the base but a polished socket is always more dependable because where cheap composition is used in the base either it will not take a polish or else the manufacturers do not bother to polish it. This does not mean, of course, that all unpolished sockets are not good but one will be safer in buying one he is sure of. Make sure that nuts are furnished for all the binding posts. This may seem like an unnecessary suggestion but one can slip up on little things like this—and dealers are careless in this respect. Dry-cell tubes do not fit the ordinary socket. Special sockets may be purchased for these, but many prefer to use regular sockets with adapters so that either the WD-11, UV-199, or regular 6-volt tubes may be used without the necessity for replacing the sockets. Some WD-11-tube sockets are simply a flat piece of insulating material with four holes to fit the prongs of the tube and with springs underneath to make contact with the prongs. There is another type which is to be preferred, however. It is shaped exactly like a regular socket except that it has no slot in the top part such as is necessary with a standard six-volt tube. One socket of this type has the contact springs bent in such a way that they press on the side of the tube prongs rather than on the ends. This is an advantage because each time a tube is inserted these springs scrape the prongs clean so that a perfect contact is made.

PANEL SWITCHES; SERIES-PARALLEL—In general, switches are all alike except for workmanship. However, there is one point in which they vary—in the way in which the switch arm is held against the switch points. They have a bushing which is inserted through the hole in the panel and a nut is screwed on the back end to hold it tight to the panel. This is the bearing for the

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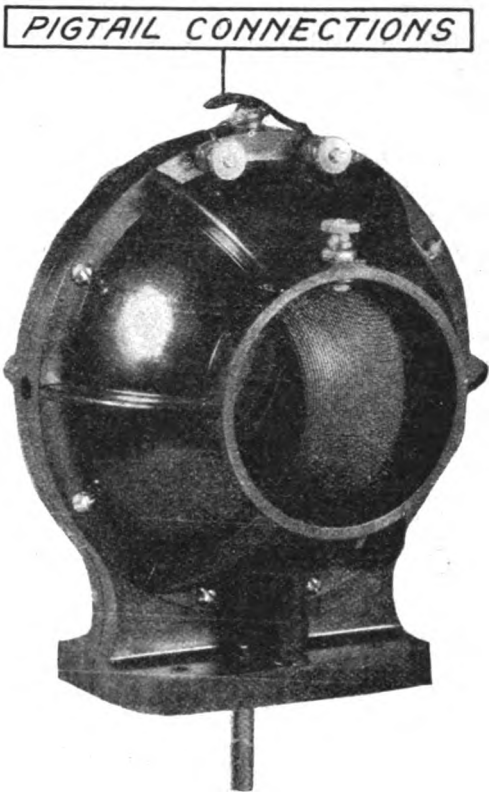
shaft of the switch arm and the shaft is slipped through the hole in this bearing. Now there must be a means of holding the arm in this bearing and it is in this that switches vary. By far the best type is that in which another metal bushing, in which there is a set-screw, is slipped over the back end of the shaft. The set-screw is tightened up so that the switch arm can revolve freely at the same time maintaining a fair pressure of the switch arm on the points. Other types use two nuts for this purpose but the objection to this type is that the nuts frequently work loose, and when a switch is mounted on a panel it is not always easy to get at these nuts to tighten them. Switch points should have heads not less than 3/16 of an inch in diameter so that the holes through which they are inserted in the panel need not be too close together.

TRANSFORMERS; AUDIO-FREQUENCY—The beginner is up against an obstacle here. To the novice all transformers look alike—and to the more seasoned fan as well. However, there are good ones and bad ones. Don't be misled by advertisers' claims because a comparison of manufacturers' claims will show that most of them say the same things about their products. By all means obtain the advice of a friend who has tried out the different makes, if that is at all possible. Generally speaking, the higher priced transformers are superior to the cheaper kinds. One cannot judge them from appearance because I have in mind one of the best that doesn't look as good as many of the cheapest. It is difficult to give detailed suggestions on this instrument. Your friend can advise you best because he can recommend certain makes that he has found to be good. A vacuum tube of low impedence requires a low-impedence transformer for best results. Do not believe everything you hear about certain transformers being designed especially for use with the WD-11 tube. I have found that while some of these are fairly good they are no better with this tube than any other standard transformers.



VARIOMETER

The frame should be rigid and the rotation should be smooth. Pigtail connections to the rotor are advisable. If pigtails are used the instrument should be equipped with "stops" to prevent twisting off the pigtails.

VARIOCOUPLERS—The most efficient variocoupler has two ball-shaped windings for the primary and secondary. In other words the secondary is wound on a wood or composition ball and the primary is wound on the *inside* of the stator or stationary form. This is not essential but is an advantage as far as efficiency is concerned. There are few made in this way and it may not be possible for the reader to obtain this type in his locality. If not the next

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best is to obtain one which has two ball-shaped windings but which has the primary on the outside of the stator. Slightly less efficient than this is a third type which has the primary wound on a bakelite or other composition tube and the secondary on a ball just small enough to rotate snugly within the primary tube. Composition tubing is to be preferred to cardboard. Pigtail connections should be used to connect the secondary winding to its binding posts. Taps taken off the primary should be so arranged that in connecting them to the switch points the coil winding will not become loosened. If the coupler is to be used in a single-circuit outfit with the secondary acting as a tickler, the 180-degree coupler gives finer tuning and is to be preferred.

VARIOMETERS—It is essential that the two windings be ball shaped and that the stator winding be on the inside of the stator form with a minimum clearance between the two windings. Variometers with excessive glue, shellac or cement on the windings are not recommended. Wood is suitable for the rotor and stator blocks provided it is thoroughly seasoned. It is not an easy matter to tell by the appearance whether the wood is well seasoned or not, however, for that reason many prefer variometers which are wound on composition forms. Pigtail connections are an additional assurance of proper operation. A last and obvious suggestion is that the purchaser make sure that the rotor does not scrape against the stator in revolving. If it does the insulation will soon become worn through and cause the two windings to short-circuit.

A last word of caution to the builder of a radio set; it may not be directly connected with the selection of parts but it is nevertheless relevant. When building a set do not try to plunge right in by making a five-tube outfit, or even one with three tubes. Start with the necessary tuning unit and a single detector tube and mount these instruments temporarily on a small board or panel. Then experiment with them until you know them thoroughly and have them working at highest efficiency. Then if you intend to add other tubes do so one at a time and become familiar with each part as you go along. When you finally have everything that is going into the finished set and all the parts are working properly, then go ahead and mount them on a regular panel.

If you follow this suggestion you will be well satisfied with your set and you will get the most enjoyment out of it.

The New and Improved Four-circuit Tuner

SINCE the publication, in the May, 1923 issue, of the Cockaday four-circuit tuner, there have been made and are now in use somewhere between 200,000 and probably twice this number of these sets. Since the article was published there have been so many improvements and changes in the circuit that the inventor has written another article, explaining how to build the set with these new and important developments incorporated in it. The four-circuit tuner de luxe *with one stage of power amplification will be described in the January issue of* POPULAR RADIO. *This set will get anything in the United States on a loudspeaker, consistently, through the local stations, without interference.*

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From a photograph made for POPULAR RADIO

THE SUBCONSCIOUS MIND MAY BE REACHED BY SOUNDS WHILE THE STUDENT LOSES CONSCIOUSNESS

In all cases sleep-listening to the code will help to master it; in some cases the results will be phenomenal.

Learning the Code While Asleep

How the progress of students may be increased as much as 100 percent by an appeal to the subconscious mind

By KENNETH M. SWEZEY

THE young aviators of the Naval Air Station at Pensacola have been successful in their attempt to become more proficient in the code by listening-in while they were asleep.

At first thought, such a proposition seems so revolutionary as to be almost foolish, but it seems so only because the principles involved are not generally clearly understood. The underlying theory is perfectly sound, and the practical application is not difficult, if the problem is approached properly. Furthermore, a knowledge of the why and wherefore and the how of these phenomena is of value to every individual operator who is willing to give it a trial.

The first observation of anything of this sort in the radio world was made, so far as I know, by Mr. Laurence M. Cockaday in 1918 while he was instructing in radio theory and operation on the U. S. Training Ship *Granite State*. Mr. Cockaday found that code students made about 100 percent better progress in learning code when messages, sent with a buzzer and received on a pair of headphones, were received in the evening just before retiring, than when the code classes were held early in the morning. In fact, code classes held just before "taps" were found to be at least 100 percent more efficient than those held at any other time during the day; that is, the evening classes ultimately learned the code in about one-half the time needed by the classes that got their practice at other times during the day.

In a report to the commanding officer

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made at that time Mr. Cockaday suggested that these experiences were probably explained by the fact that the students were able to sleep with the code firmly fixed in their minds without any other thoughts intruding for a considerable period of time. It was recommended that the students practice the code shortly before hammock-time, so that they could "sleep on it."

These observations do not seem to have attracted much attention at the time, and the matter remained unnoticed until the recent tests at Pensacola. Several experienced operators have assured me, however, that if one falls asleep with the phones on his ears, or if one is reading a book and not paying particular attention to what is coming in, code messages may be received unconsciously. On waking or on coming out of his "brown study," the operator is likely to find fixed in his brain the meaning or even the exact words of messages that were received while he was inattentive.

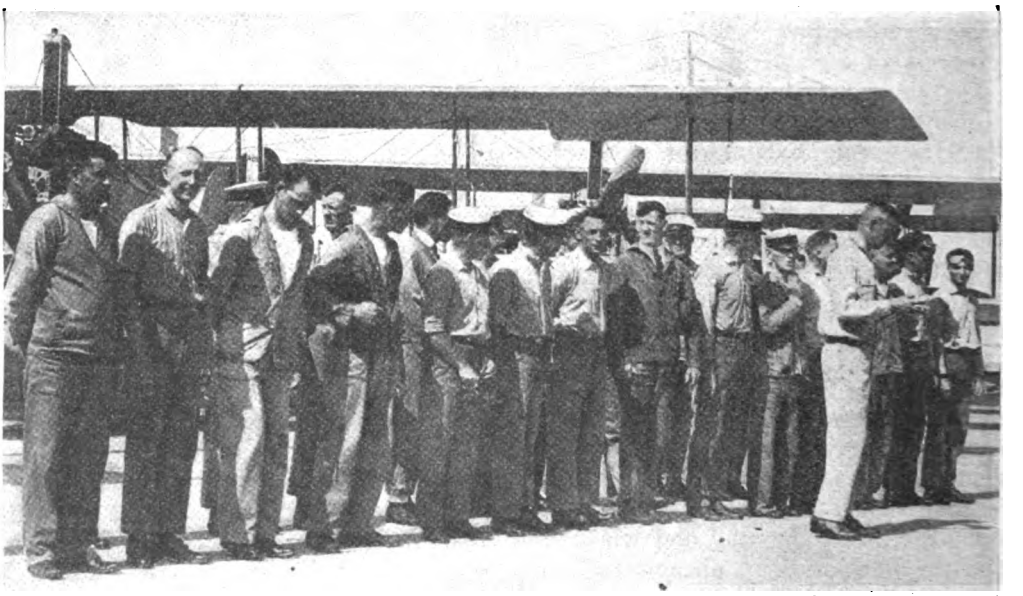
The following paragraphs attempt to give an explanation of these phenomena in the light of modern psychology, and also to describe a fairly positive method of carrying out this learning-while-asleep procedure most satisfactorily.

First let us consider the mind.

This complex something is not a unified whole, as is generally supposed. It is divided into two main divisions, the *conscious* mind and the *subconscious* mind.

The conscious mind is our reasoning mind; our volitional mind. With it we make our decisions, solve our problems, cause our arms and our hands to move, talk, become conscious of what we hear and what we see, and perform all other duties and functions that are under the direct control of our will.

The subconscious mind, in our present stage of development, is quite dis-



Official photograph U. S. Navy

HERE ARE THE MEN WHO ARE LEARNING THE RADIO CODE WHILE THEY SLEEP

Upon this group of students at the Naval Air Station at Pensacola, Florida, the Navy Department is conducting a novel and apparently successful experiment.

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International

THE ONLY CLASSROOM IN WHICH SLEEP IS PRESCRIBED

While the students of this remarkable school for naval aviators at Pensacola are dozing off with headphones over their ears, the operator sends a continuous flow of code messages.

tinct from this conscious mind. It is an automatic, rather than a reasoning mind. It cannot make decisions of its own but must take the decisions that are handed down to it by the conscious mind, and carry them out. It is this subconscious mind that controls all the automatic functions of our bodies; such as the beating of the heart, the production and the repression of the gland secretions and the other body functions over which we do not have any direct control. The subconscious mind has an almost perfect memory of things impressed upon it. It is the photographic plate upon which our life's experiences are recorded. Its makeup determines our personality.

We are more subconscious than we might think; scientists tell us we are fully ninety percent so. Yet the vast resources of this mind remain untapped by most of us for the reason that we have been living for so many centuries in the conscious, or superficial, aspect of our minds that we have forgotten how to go back.

Let us take an example:

We want to recall some incident of a week ago. I have said that the memory of the subconscious is almost perfect. How is it, therefore, that the particular incident we want has "slipped our mind?"

We may rest assured that the information we want *is* still with us, that it has not really slipped out. It has merely passed from the surface of our mind to the depths. If the incident had made any great impression at the time of its occurrence we would be able to recall it instantly. But evidently it did

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not, so it has drifted to its permanent filing place. It is the same as putting our money in the safe and forgetting the combination.

The only thing to do in such a case is to let our mind rest for a few moments in a passive state or else to go about our work until the forgotten incident rises up from our subconscious mind and, as we say, "it comes to us."

Did you ever notice how difficult it is to concentrate on one subject for more than a very short time? Suppose you are studying code. Every few minutes some irrelevant thought floats into your consciousness and throws you off the track.

These are thoughts of the conscious mind. They interfere with reaching the subconscious and making a deep impression on it. When you are asleep you do not have them. The subconscious mind is reached more directly and is more deeply impressed.

This is especially true of things that enter your mind while you are in a partly unconscious, very suggestible state just before you go to sleep. These are the things you dream about.

In the same way thoughts you have just after awaking, when your subconscious mind is more easily accessible, are likely to be the ones that carry their impressions all day long.

Such was Coué's theory when he suggested that you say to yourself twenty times before retiring each night, "day by day in every way I am getting better and better."

When a person sleeps, he loses his consciousness—but that is all. The subconscious is as active as usual; otherwise life would be extinguished from the body. The subconscious may be reached from external sources, for example, by sounds.

Now we come to the application of the principles outlined to the studying of the radio code. Can it be done successfully, and if so, what is the best method to follow? In answer, it may be said that in all cases sleep-listening will help; in many cases the results will be remarkable, and in a few cases phenomenal. The writer does not know exactly how the experiments were carried on at the Pensacola station, but if the following directions are adhered to, you are quite sure to get positive results.

Let us first mention the rules for doing the best work at ordinary daytime operating. Old-time expert operators might consider these externals all a lot of bosh; but you will find in all cases good operators follow them, even though they may not realize that they do so.

Select a seat that is comfortable, and in which you may relax as much as possible. Try to relieve every physical tension, by just "letting go" at the spot. Then try to make your mind a blank and to become passive. Throw out all the fool thoughts that flit up. Concentrate on the subject at hand—that of reception; and *perfect* reception. The relaxation and passivity as preliminaries will make the concentration easier.

Listen in for about fifteen minutes or more each night, just before going to bed—to code, of course. And from the time you get into bed until you go to sleep, keep your mind on nothing but dots and dashes. If you can stand keeping the phones on your ears, try that; if you can't, move a loudspeaker close to your head, but it is not necessary to have it going too loud. Sincerely try to believe that the signals will continue to impress themselves on your subconscious mind after you have passed the borderland of consciousness.

If you are earnest in your endeavor this will really happen. And the next morning you will wake up with a greater ability at receiving code than ever before. It is a psychological law, and must work if properly applied. And ability thus gained will stick by you permanently.

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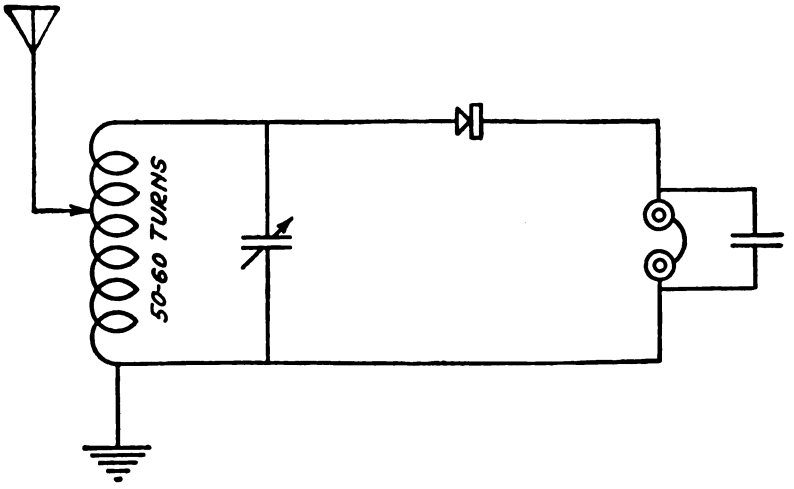

THE CAPACITY-TUNED CRYSTAL CIRCUIT

Cost of parts: Not more than $12.00.

Selectivity: Good.

Operation: Simple. Only two controls; a primary slider and a secondary variable condenser.

Ease of construction: Nothing complicated.

Approximate range: 15 miles.

Outstanding features: The circuit is more selective than the ordinary conductively-coupled tuner and the variable condenser gives smoother wavelength control.

100 BEST HOOK-UPS

INSTALLMENT NO. 2

IN this series of hook-ups will be published—for the special benefit of the radio novice who is undecided as to just what circuit he wants—100 of the best radio receiving circuits, each thoroughly tested. The approximate ranges given here are averages based on actual records made with receiving sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, in the best of conditions, the actual ranges may exceed the values given by as much as 500 percent.

In the November number the following hookups were published:

The Conductively-coupled Crystal Circuit; *range* 15 miles; *cost*, $10.00.

The Inductively-tuned Crystal Circuit; *range* 15 miles; *cost*, $15.00.

The Combination Tuned-plate, Ultra-audion Circuit; *range* 500 miles; *cost*, $25.00.

The Man-Day Single-control Regenerative Circuit; *range* 500 miles; *cost*, $12.00.

The Reinartz Circuit, with Two Stages of Audio Amplification; *range* 1,500 miles; *cost*, $35.00.

Tuned Radio-frequency and Regenerative-detector Circuit; *range* 500 miles; *cost*, $28.00.

The Squire Reflex Circuit; *range* 500 miles; *cost*, $50.00.

Triple-coil Honeycomb Regenerative Circuit with Two Stages of Amplification; *range* 100 miles; *cost*, $35.00.

The Grimes Reflex Circuit; *range* 500 miles; *cost*, $40.00.

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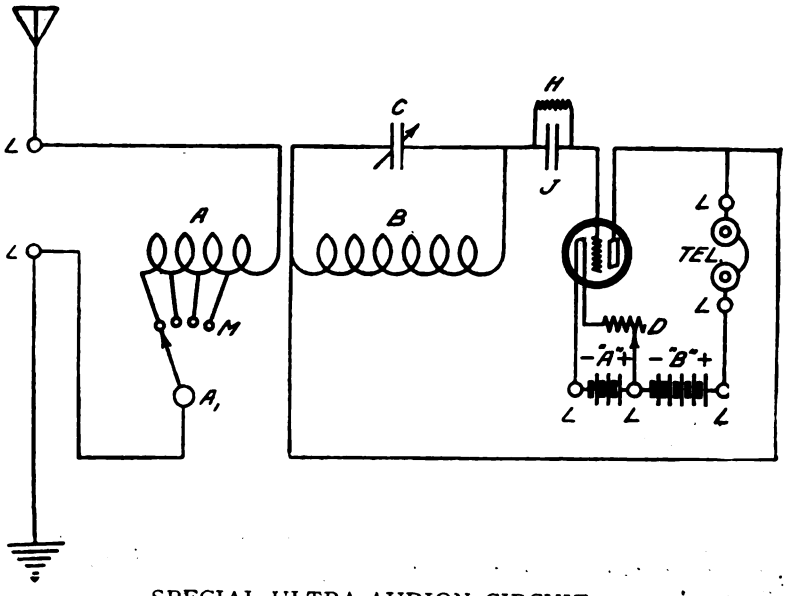
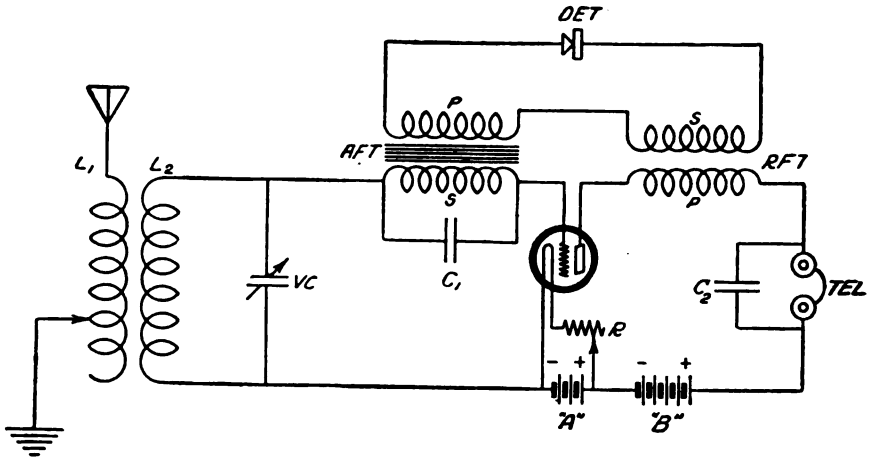


SPECIAL ULTRA-AUDION CIRCUIT

Cost of parts: Not more than $12.00 (Note: The costs of tubes and batteries are considered "extras" and are not included in the costs given in these descriptions).
Selectivity: Excellent.
Operation: Very easy. When the switchpoint A1 is adjusted for the antenna, there is only one control for wavelength. The regeneration is controlled by the filament rheostat.
Ease of construction: Simple.
Approximate range: 500 miles.
Outstanding features: This circuit shares first place with the Man-Day circuit in simplicity of operation. It is very selective, and costs but little.



SINGLE-TUBE AND CRYSTAL REFLEX CIRCUIT

Cost of parts: Not more than $28.00.
Selectivity: Very good.
Operation: Fairly simple. Two controls for wavelength and one coupling control are used. The crystal adjustment must be changed for any considerable change in wavelength in order to prevent the circuit from oscillating and still have it retain its maximum signal strength.
Ease of construction: More complicated than the straight regenerative circuits but not beyond the ordinary radio fan's ability.
Approximate range: 1,000 miles.
Outstanding feature: Circuit combines radio-frequency, and audio-frequency amplification and regeneration in one tube.

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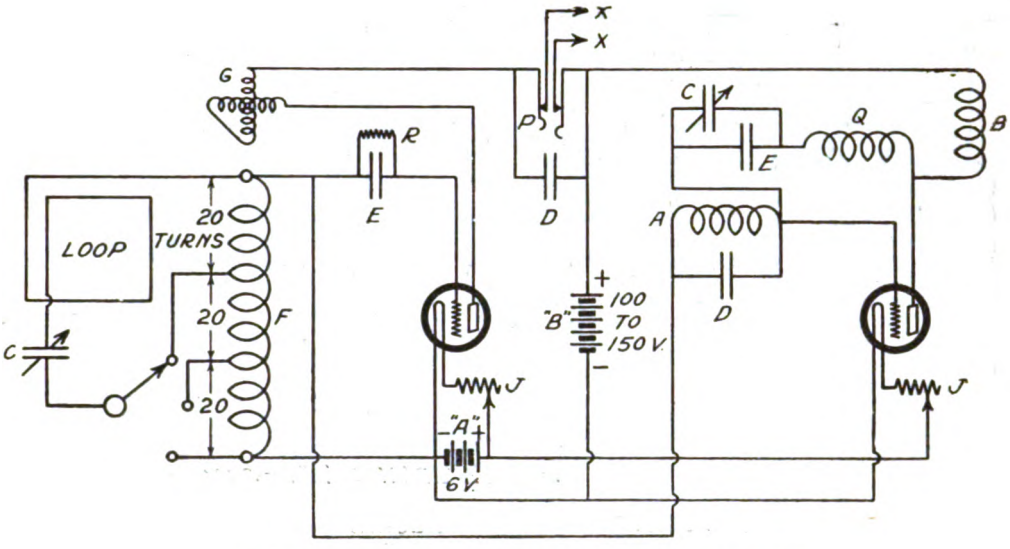
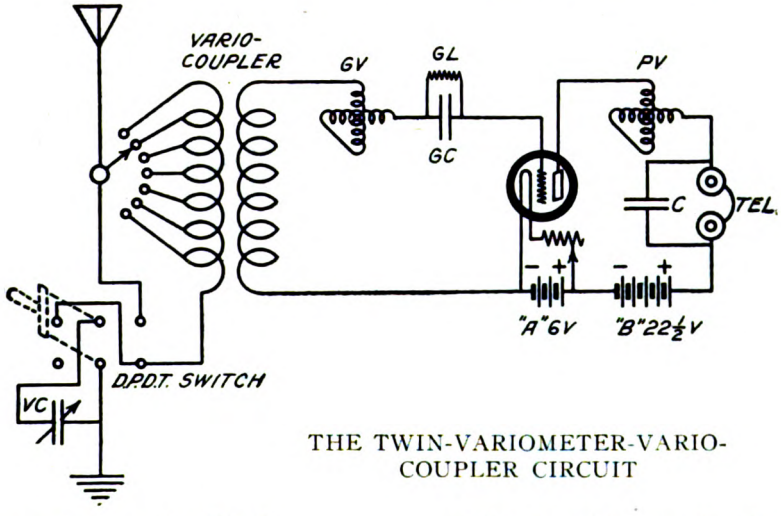


TWO-TUBE SUPER-REGENERATIVE CIRCUIT

Cost of parts: Not more than $45.00.
Selectivity: Good.
Operation: Difficult. It is a real engineering feat to get the oscillator circuit to function with the correct frequency and amplitude to cause the proper "super" action and at the same time filter out the high-pitched whistle in the detector circuit.
Ease of construction: Difficult. Every part of the circuit must be just right before the set will function as it should.
Approximate range: Variable: from local reception on the higher broadcasting wavelengths up to 1,000 miles on lower wavelengths (with a loop).
Outstanding features: The best method for unlimited amplification at the extremely short wavelengths. Especially suitable for local reception with great volume for a minimum number of tubes.



THE TWIN-VARIOMETER-VARIO-COUPLER CIRCUIT

Cost of parts: Not more than $30.00.
Selectivity: Good.
Operation: Requires considerable skill which can be acquired in a couple of months of experimenting with the tuning.
Ease of construction: Just an ordinary acquaintance with tools but some electrical ability in wiring up the circuit is necessary.
Approximate range: 500 miles.
Outstanding features: This was the first well-known short-wave regenerative receiver and it has been found reliable and probably has been more used than any other type of receiver in the past.

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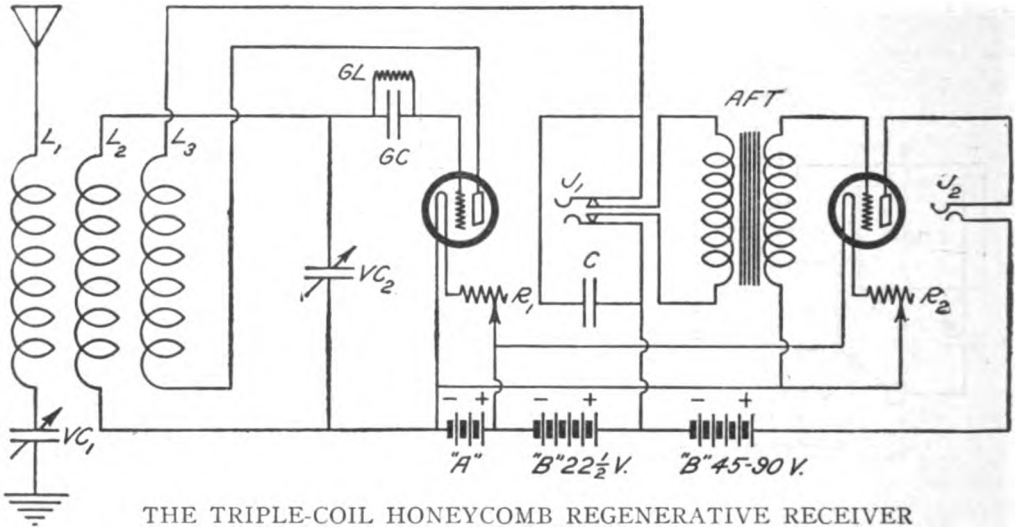
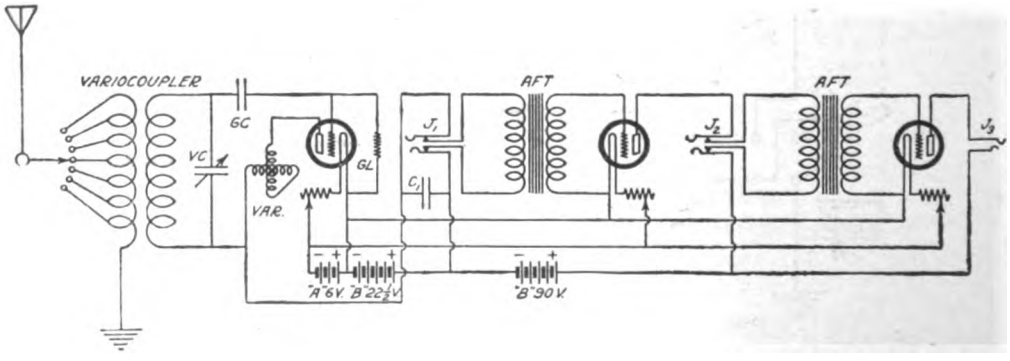


THE TRIPLE-COIL HONEYCOMB REGENERATIVE RECEIVER
WITH ONE STAGE OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Between $25.00 and $30.00 (depending on the wavelength).
Selectivity: Very good.
Operation: Rather complicated for a beginner.
Ease of construction: Fairly simple.
Approximate range: 800 miles.
Outstanding features: Can be used on any wavelength. By merely changing the three coils, using large or small, for the long or short waves, the set can be used for commercial reception, broadcast reception or amateur reception.



MODIFIED DX THREE-CIRCUIT REGENERATIVE RECEIVER, WITH
TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $35.00.
Selectivity: Excellent.
Operation: Fairly simple.
Ease of construction: Fairly easy to build.
Approximate range: 1,500 miles.
Outstanding features: Noted for DX amateur and broadcast reception and for its exceptionally sharp tuning.

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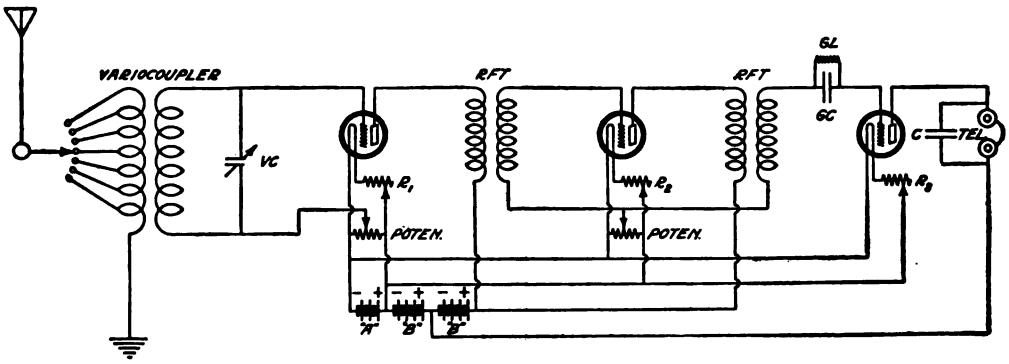
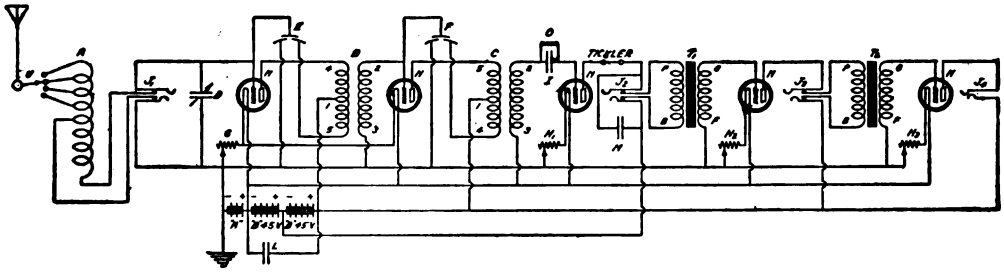


TRANSFORMER-COUPLED RADIO-FREQUENCY CIRCUIT WITH VACUUM-TUBE DETECTOR

Cost of parts: Not more than $35.00.
Selectivity: Good.
Operation: Simple. Two controls for wavelength, one for coupling and one for regeneration (the potentiometer).
Ease of construction: Not easy for the experimenter to get working right but a little patience and experimenting will soon get results.
Approximate range: 1,000 miles.
Outstanding feature: Although the amplification with this type is not as great (per stage), as with tuned-radio-frequency amplification, the tuning control is simplified.



MODIFIED ACMEDYNE CIRCUIT WITH TWO STAGES OF COMPENSATED RADIO-FREQUENCY AMPLIFICATION AND TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $60.00.
Selectivity: Wonderful.
Operation: Rather complicated for the beginner, but the correct method can be acquired in a month's practice in tuning.
Ease of construction: This, of course, is a complicated circuit to follow out and to get going properly, but it can be done and the set is well worth while.
Approximate range: 2,500 miles.
Outstanding features: Extremely sharp tuning, DX reception and clarity of signals. The trouble encountered in most radio-frequency-amplification circuits, that of properly controlling or eliminating oscillation, is definitely taken out of this circuit by an ingenious device called a compensating condenser which has three plates attached respectively to the grid, filament, and plate circuits of the vacuum tubes.

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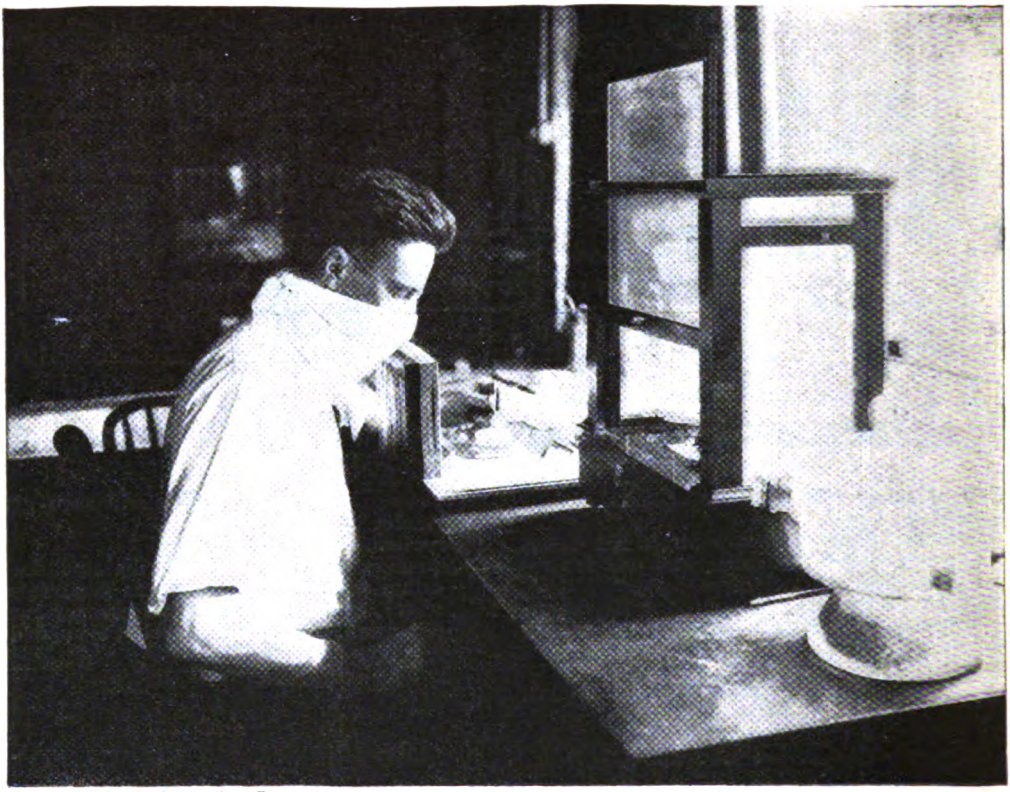

Courtesy United States Radium Company

WHERE A SNEEZE MIGHT COST $1,000.00

This shows how radium preparations worth thousands of dollars a grain are weighed and handled. The lead plate in front of the operator protects him from the very short ether waves given off by radium.

Do Ether Waves Cause Gravitation?

Scientists are coming to believe in the existence of a new kind of ether waves, the ultra-X rays. Knowledge of these remarkable rays may solve for us some of the most fundamental scientific mysteries. This article describes the latest developments in this up-to-the-minute field of research and speculation.

By E. E. FREE, Ph.D.

THE real nature of the universe has always been a mystery. The distant suns that we call stars are composed, we know, of matter like the matter here on earth—but what *is* matter?

Light comes to us from these stars through the ether—but what is ether?

The planets hold their paths around the sun because of gravitation—but what is gravitation?

For more than six thousand years philosophers have been seeking to unlock these fundamental mysteries. Now, at last, it seems as though we may have found a key.

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It is radio.

The family of ether waves, some of them the nightly companions nowadays of the possessor of a radio set, may turn out (some scientists believe) to contain a member that is not only the key to the great mystery of gravitation but perhaps to still deeper mysteries; the mystery of energy, the mystery of the sun's heat, the mystery, even, of life itself.

The story of these new ideas begins with the suspicion that there may exist in the universe a new kind of ether waves, hitherto unsuspected, which are characterized by extremely short wavelength. They are much shorter, even, than the X rays. That is why they have been named the ultra-X rays, just as the waves next shorter than those of violet light have been called the ultra-violet.

The whole family of known ether waves stretches, you remember, from the very long waves of radio, thousands of meters long, down through heat waves, light waves, the ultra-violet and the X rays to the shortest known waves, those given off by radium.* The shortest waves yet detected come from a variety of the radioactive element called thorium and have a wavelength of about one million-millionth of a meter.

This is a very short wave according to ordinary standards. If you laid a piece of this kind of thorium on your hand, with a sheet of tissue paper in between so that the rays from it had to penetrate the paper before they could reach your hand, there would be room for about ten million separate waves in the thickness of the paper. There is quite a contrast, you see, between these shortest known waves and the great waves used in radio telegraphy, some three or four hundred of which will span the Atlantic.

But tiny as these shortest waves are, millions of them inside the smallest speck of dust that you could see, science knows some things that are still smaller. The electron, for example, is some three hundred times smaller. There would be room for nearly three hundred electrons along a single one of these shortest waves, and for some three thousand million electrons, therefore, in the thickness of a sheet of tissue paper.

Now these very short waves are merely the shortest *known* waves. There is no reason to believe that they are the shortest that exist. The ultimate structure of the universe, whatever it may be, is obviously much finer-grained than this. The electron, which is quite definitely known, is smaller and there are almost certainly a number of perfectly real and separate things, for example, the central nucleus of the hydrogen atom, that are smaller even than the electron. There is plenty of opportunity, then, for waves a hundred times or a thousand times shorter than these shortest known ones without exceeding the smallest dimensions that we know to be possible.

The question has been, of course, whether any such very short, unknown waves actually do exist.

Scientists are coming to believe that they do, though because they penetrate all kinds of matter so readily they are extremely difficult to detect. Even the X rays, which are some thousands of times longer, penetrate our bodies, for example, with the greatest ease. These ultra-X rays, if they exist, would go through us (probably) as though we were not there at all. They would also go right through our physical instruments and our photographic plates and all the other material things that we are accustomed to use in detecting various kinds of ether waves.

We can stop light rays with a mirror or bend them with a lens, and that enables us to study the nature of light. The ordinary X rays, being so much shorter than light waves, go right

*Details of this ether wave family were described in POPULAR RADIO for November, 1923, page 407.

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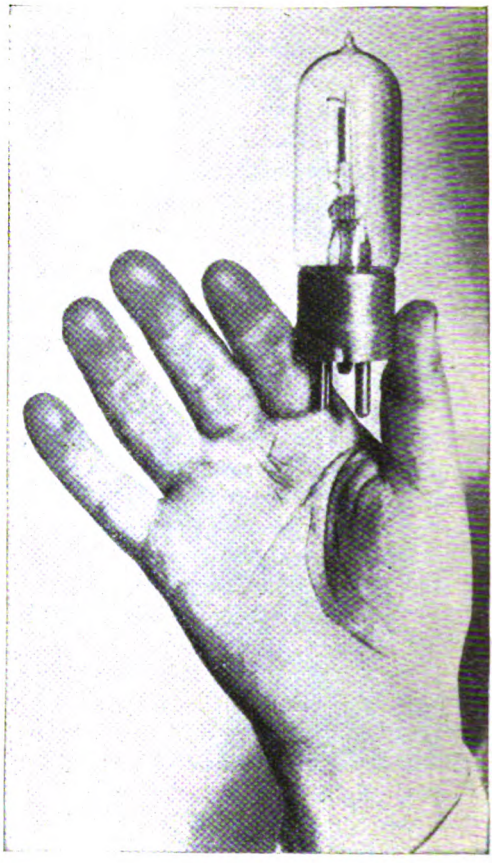
From photographs made for POPULAR RADIO

BY INFRA-RED RAYS

The following pictures show the different transparencies of things for different kinds of waves. This view corresponds to rays, like the infra-red rays, to which both the hand and the glass globe are perfectly opaque—all waves being absorbed.



BY VISIBLE LIGHT

This is a similar photograph taken with ordinary light, the waves of which are shorter than those of the infra-red. The hand is opaque but the glass globe is transparent to these waves, so that the metal parts inside may be clearly seen.

through lenses or mirrors as though they were not there. So we cannot study X rays with such ordinary instruments. But a sheet of lead will catch the X rays and some kinds of crystals will catch them in part and bend them, and so we have been able to study these ordinary X rays by using metal sheets and crystals and similar devices instead of lenses and mirrors.

The ultra-X rays, however, may go right through lead sheets just as ordinary X rays go through a mirror. They probably do, in fact, go right through everything. We are left, then, with nothing in the way of apparatus that will catch these exceedingly elusive, mightily penetrating rays so that we can study them. This explains how these rays have escaped discovery for so long in spite of the fact (if we are right in thinking that it is a fact) that these rays exist and are vastly important in the world.

But *is* it a fact? What makes the scientists believe that some very short ether waves like this are a physical actuality and not merely something that is possible theoretically?

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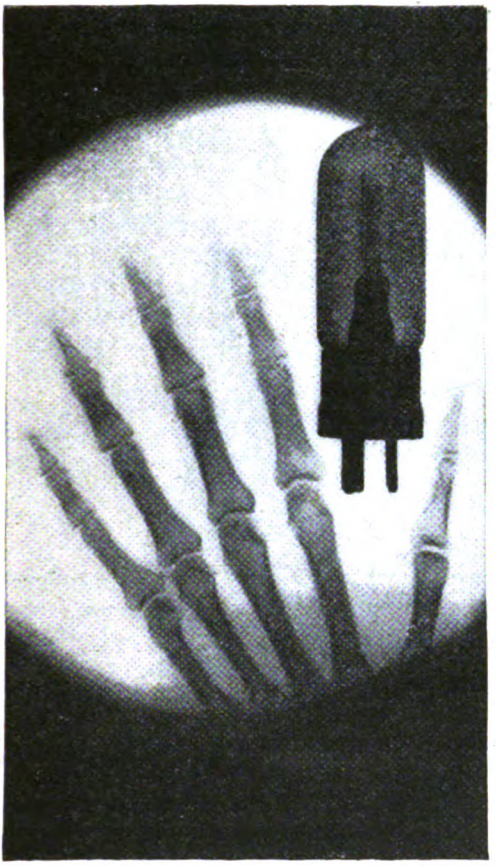

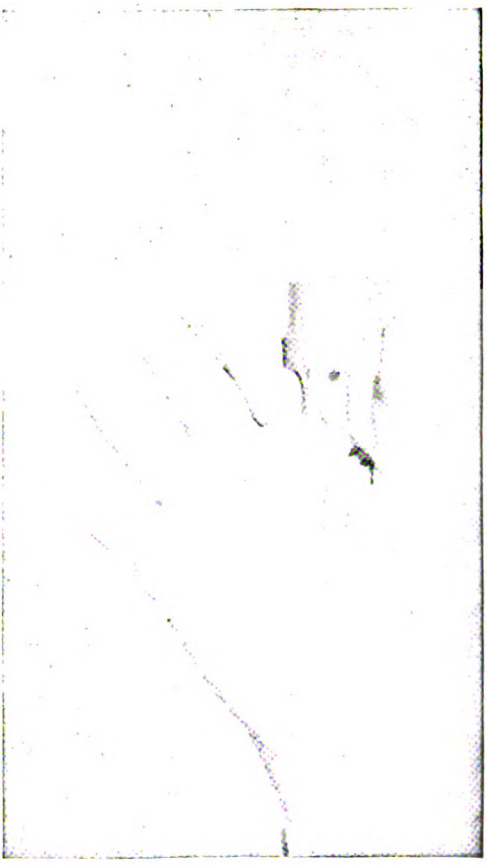

From an X ray photograph made for POPULAR RADIO by Dr. George Palmer Ratner, N. Y.

BY X RAYS

This is the same hand and globe photographed by X rays. Being shorter than the waves of light, these X rays penetrate the flesh so that the bones may be seen. The metal parts of the tube are perfectly black, showing complete absorption of the waves.

BY ULTRA-X RAYS

This is how a hand might look if it could be photographed by the supposed ultra-X rays. These rays, the shortest waves of all, would penetrate flesh, bones and glass globe with almost complete perfection, showing only the faintest possible shadow.

The first suspicion to this effect arose in connection with an effort to explain the peculiar behavior of radium. The atoms of radium, you remember, are in the habit of exploding. In a little piece of radium, containing, of course, billions of billions of individual atoms, a certain number of the atoms blow up every second and keep on doing so, one by one, until all the radium is gone. There are so many atoms in even the smallest speck of radium that the disappearance of the material is extremely slow; only half of it will be gone, in fact, after two thousand years. But it does disappear, however slowly, and this is what causes the continual production of heat and the discharge of tiny particles and of other rays, all of which taken together constitute the phenomena of radioactivity.

The cause of this has always been a puzzle. Why should the radium atoms blow up? It is possible, of course, that they do so spontaneously, just as badly-made dynamite goes off occasionally all by itself. But this has never seemed very likely. Scientists have always believed that there probably was something that touched off the indi-

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vidual radium atoms once in a while, just as we use an exploder cap to touch off a stick of dynamite. Only we have never been able to find out what this radium exploder was.

About four years ago the distinguished French physicist, Dr. Jean Perrin, the same who had discovered, some years earlier, the first direct proof of the real existence of molecules, suggested that the radium exploder might be a kind of ultra-X rays. The radium atoms might have, he pointed out, the power of absorbing these very short waves just as a black wall will absorb light or a lead plate will absorb X rays. And as a strong light absorbed by a black wall will heat up the wall a little and a beam of X rays, if it be strong enough, will heat up a lead plate, so the absorption of ultra-X rays by the atoms of radium ought to add energy of some sort to the atom; so much energy, perhaps, that after a while the atom would explode.

Suppose you take a tightly closed can of gasoline and put it in the hot sun. Or suppose that you get a large burning glass and focus it on the can of gasoline so that the sunlight that strikes it will be much stronger. The can will explode. It absorbs more and more energy from the sunlight. It gets hotter and hotter. Finally there is so much heat energy in it that the can cannot stand it any longer and it blows up.

Something of this same sort may be happening, Dr. Perrin suggested, to the atoms of radium. They may be absorbing all the time a little of the energy of the ultra-X rays. This energy accumulates inside the atoms just as the energy of sunlight accumulates inside the can of gasoline. Every once in a while an atom gets so much of this extra energy that it blows up.

The atoms of the other elements, the ones that are not radioactive, might be, Dr. Perrin thought, totally transparent to the ultra-X rays so that they caught no energy from them and were not affected. Just so the sunlight passing through the transparent pane of a window will warm any dark-colored (and therefore absorbing) object inside, leaving the non-absorbing pane unaffected and cool. According to the Perrin theory the only kinds of atoms that had the property of absorbing the ultra-X rays at all were the atoms of the radioactive elements. These were the only elements, therefore, that could accumulate the ultra-X-ray energy and explode.

This, of course, was only theory. It was a way of explaining the behavior, otherwise so mysterious, of the radium atoms in exploding every once in a while without having anything to touch them off. Dr. Perrin did not catch or measure any ultra-X rays or produce any direct experimental evidence that they existed.

This step was left for an American scientist, Dr. R. A. Millikan of the California Institute of Technology. By ingenious experiments which he described recently before the American Institute of Electrical Engineers but which he has not yet published in detail, some rays similar to the supposed ultra-X rays seem actually to have been detected. Experiments on top of California mountains and in airplanes high above the earth indicate that these new rays come from space outside the earth. They do not come from the sun, for they are observed at night as well as during the day.

Dr. Millikan has established, also, a probability that radium atoms are not the only ones that sometimes explode. All kinds of atoms explode occasionally, but the ordinary kinds, like the atoms that compose our bodies, do so only once in a long time. All substances, says Dr. Millikan, are probably radioactive just as radium is but much more faintly, so faintly that the fact had hitherto escaped observation.

Dr. Millikan is not ready (if I correctly understand his position) to give

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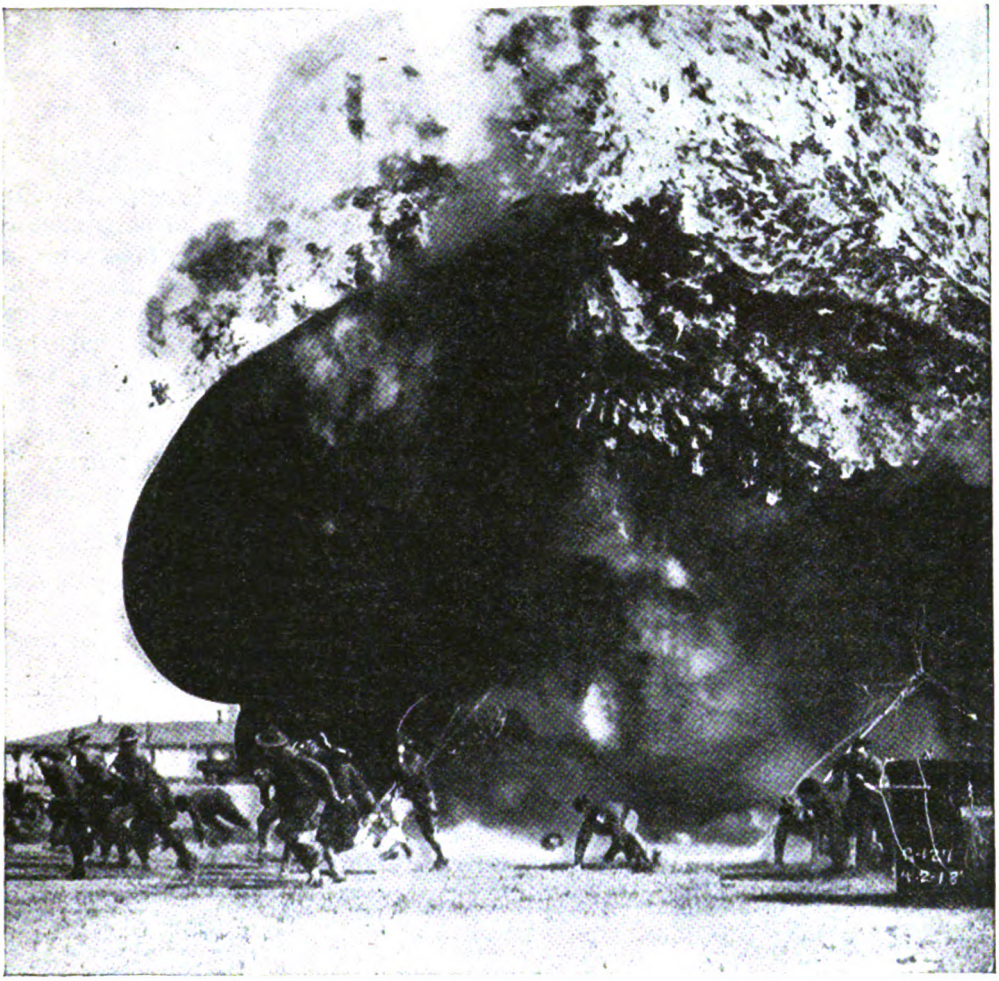

Signal Corps, U. S. A.

A VERY MILD EXPLOSION—FROM THE ATOM'S VIEWPOINT

This explosion of a hydrogen-filled army balloon, Goodrich Type R72, is among the most violent explosions ever photographed, according to human standards. Yet the explosions of the radium atoms, perhaps induced by the ultra-X rays, are millions of times more violent, bulk for bulk, than this one is. This remarkable snapshot was taken April 2, 1918, at Fort Sill, Oklahoma, by Captain Roger B. Whitman.

full agreement to Dr. Perrin's idea that the ultra-X rays produce all these atomic explosions, both of radium and of other kinds of matter. But he is willing to grant the fact that these ultra-X rays, or something very like them actually exist. We can conclude, then, that the family of ether waves is reasonably certain to have a shorter brother; a tiniest one of all who is so small that science has not previously seen him.

The problem arises, then, whether this newly discovered member of the family may not have some rather important jobs. None of the other kinds of ether waves are loafers. Light and heat rays and the X rays are all doing rather significant jobs in the universe; for example, helping to keep us alive and to keep the world habitable. Perhaps the smallest brother has something to keep busy on too.

This problem had been attacked even before Dr. Millikan's experiments by

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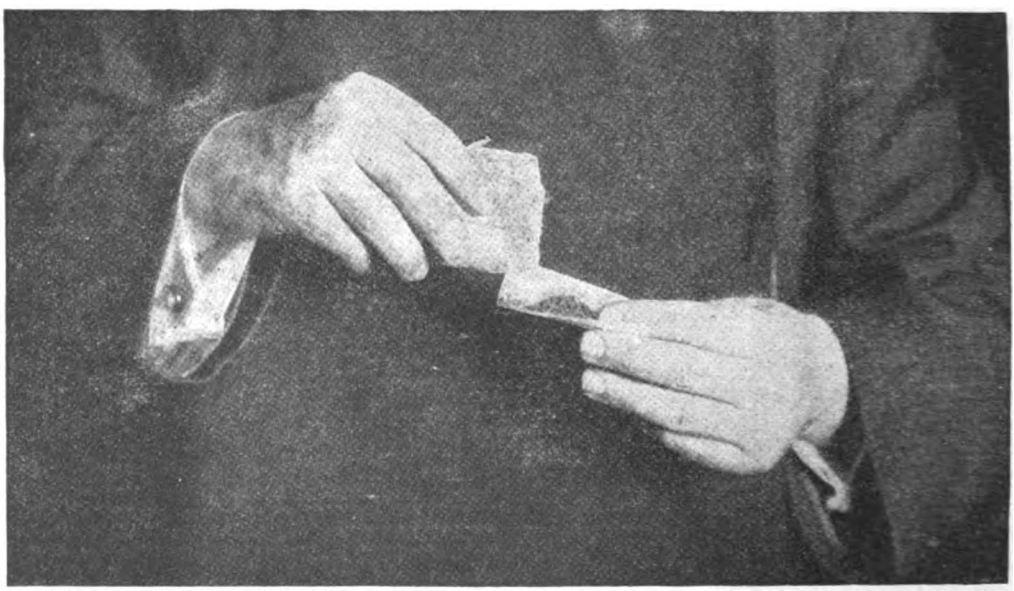
a compatriot of Dr. Perrin, Dr. Felix Michaud, a well-known physicist and distinguished member of the Faculty of the University of Paris. These ultra-X rays may be, Dr. Michaud thinks, the most important ether waves of all. The littlest brother may be the most powerful. He may be, in fact, the cause of that age-old mystery that we call gravitation.

Let us imagine, says Dr. Michaud, that the entire universe is filled with a vast assemblage of ultra-X rays, moving in all possible directions at the same time, just as a mirror-walled and brilliantly lighted room is filled with a multitude of light rays, crossing and interlacing and filling every tiniest cranny of the space inside the room. We do not perceive this vast flood of ultra-X rays that comes from every direction and bathes everything because the rays go right through us. Just so a perfectly transparent object in the lighted room, if there were such a thing as a *perfectly* transparent object, would be utterly invisible. Nor, if this object had a consciousness, would it perceive the light that was passing all around and through it. To it the brilliant room would seem dark.

Just so the universe, brilliantly "illuminated," so to speak, with the ultra-X rays, appears to us to have none of them because we are transparent to them and cannot perceive them at all.

But just as there is no known object, even the clearest glass or the most brilliant crystal, that is *perfectly* transparent to light rays, so there is no substance that is *perfectly* transparent to the ultra-X rays. We ourselves, the earth under our feet, every kind of matter everywhere in the universe, absorbs a tiny fraction of the rays, just as a "transparent" glass really absorbs a tiny fraction of the light.

But if we do absorb even the tiniest fraction of the ultra-X rays it ought to have *some* effect on us; we ought, in some way, to be able to perceive it. It has, says Dr. Michaud, an effect on us;



From a photograph made for POPULAR RADIO

THIS CIGARETTE PAPER IS TWENTY MILLION WAVES THICK

It is so thick in comparison with the wavelength of the gamma rays given off by radium that there would be room for nearly 20,000,000 single waves in one thickness of the paper. The ultra-X rays are believed to be even shorter than this.

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we do perceive it, but we do not recognize it as a radiation.

What it really does, this tiny absorbed fraction of the pervasive flood of ultra-X rays, is to cause gravitation.

Consider, says Dr. Michaud, two almost transparent objects, like two glass balls, inside our mirror-lined, brilliantly-lighted room. Each ball absorbs a little light. If the balls are fairly close together each will shade the other just a trifle. Delicate light-measuring instruments would show that the side of each ball that faced toward the other ball would be receiving all the time a little less light than the other sides of the balls freely exposed to the flood of light in the room.

This is what is happening to two material bodies, like the sun and the earth, floating in space. Space, you remember, is considered to be full of a flood of ultra-X rays just as our room is full of a flood of light. The sun and the earth each allow most of these ultra-X rays to pass right through them just as most of the light passes through the glass balls. But the matter of the sun and the earth absorbs a tiny fraction of the rays and so the two great globes shade each other a trifle from the pervasive ultra-X rays, just as the two glass balls in the room shaded each other a little from the pervasive light.

But how, you say, does this explain gravitation?

Because all kinds of rays, when they are absorbed, create a pressure on the thing that absorbs them. This was proved years ago for light by two American physicists, Dr. Ernest F. Nichols and Dr. Gordon F. Hull. Light exerts a pressure and this is why, for example, the tails of comets point away from the sun. The little particles of dust in the tail are driven backward by the pressure of sunlight.*

The ultra-X rays, like light and all other kinds of ether waves, may be expected to exert a pressure also. If the earth were floating alone in empty space the pressure would be the same on all sides of it, for the amount of the ultra-X rays arriving from any selected direction would be exactly the same as the amount arriving from every other direction. But the earth is not alone in space. It is accompanied, for example, by the sun. Therefore, the sun shades it partly and the earth partly shades the sun. The pressure of the ultra-X rays is slightly less on the near sides of the sun-earth combination, or, what is the

HE ORIGINATED THE ETHER-WAVE THEORY OF GRAVITATION

Dr. Felix Michaud, distinguished physicist of the University of Paris, whose theory that ether waves cause gravitation is explained in in this article.

*See POPULAR RADIO for August, 1922, pages 249-255.

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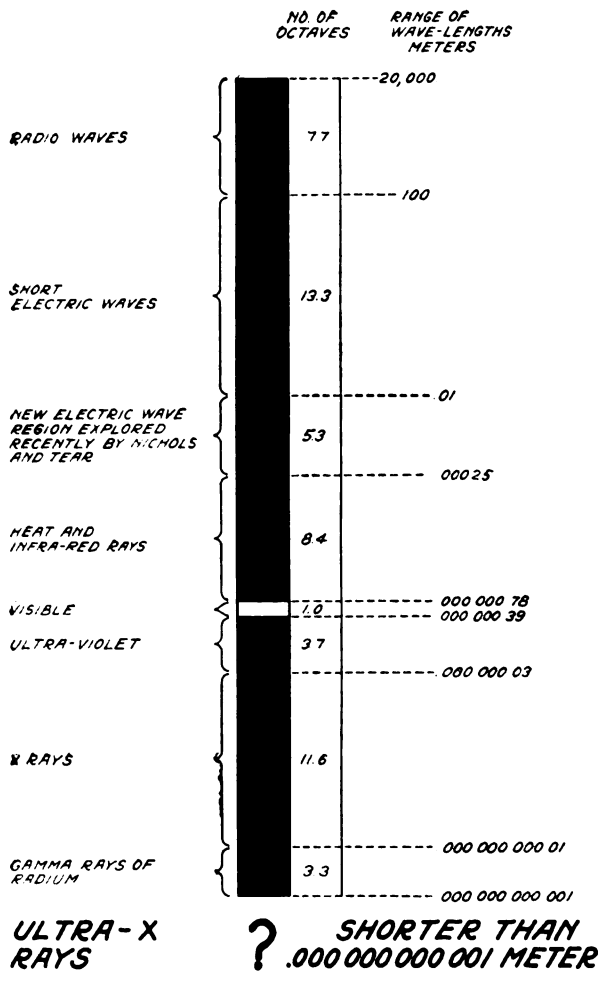

THE COMPLETE ETHER-WAVE SERIES

This chart shows the supposed ultra-X rays as the shortest ether waves of all.

same thing, it is greater on the far sides. There is a force tending to drive the sun and the earth together. That is what we observe and call gravitation. Extend this same reasoning to all the other bodies in the universe, work out the detailed relations of the amount of ultra-X ray absorption to the masses of bodies, to the distances, to relative motions and the like (all of which Dr. Michaud has done) and you come out with the well-known laws of gravitation.

You come out also with a possible explanation for that very puzzling mystery of where the sun gets the energy to keep up its heat. The sun, geologists tell us, is at least six or eight billion years old. No kind of burning would supply its heat for even a thousandth of this time. What does give it its heat?

Perhaps, says Dr. Michaud, it is the great flood of ultra-X-ray energy that fills all space. The part of this that the sun absorbs and which is manifested, as we have seen, in gravitation is very tiny with relation to the total amount of such energy that space contains. But

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it may be very large with relation to the sun; ample, perhaps, to keep the sun going indefinitely.

This same unsuspected source of energy, if it really exists, may have important significance for the problems of life, especially of life on other planets. The surface of Mars, for example, has been found, by measurement of its radiation, to be considerably warmer than the usual theories would indicate as possible. It seems warm enough, in fact, to support life quite like the life on earth. Where does this warmth come from? Not from the sun, we are sure, unless the atmosphere of Mars is of some peculiar composition and is able to trap and retain the sun's heat much more efficiently than the astronomers suppose. Perhaps the extra heat comes from ultra-X rays absorbed from space by the matter of the planet, just as does (so the theory says) the heat of the sun.

If this be true some heat like this must be arriving all the time on the earth. Very likely it is. It has long been known, for example, that all rocks, soils and natural waters are slightly radioactive. The heat thus produced has been ascribed by most scientists to traces of radium in the rocks. It has been calculated to be sufficient to make the earth grow slowly warmer instead of cooling off as the older theorists used to believe. Perhaps this, too, may be an ultra-X-ray effect. Even our own life may depend in ways that we do not yet understand, upon the properties of this new and remarkable kind of ether waves.

There are many other implications of this ultra-X-ray theory. Some affect the theories of astronomy. Others have to do, as Dr. Perrin foresaw, with radioactivity. Still others concern the cause of light or of those mysterious effects that we call electricity and magnetism. I cannot describe here the details of all these conclusions and suggestions and possibilities. Perhaps, indeed, it is profitless to describe them at all until the exact facts about these ultra-X rays have been ascertained and fully proved. That, we may be sure, will not be a matter of many years.

But there is one thing, even at present, that I must not leave unsaid. It is that in these experiments of Dr. Millikan and in the theories of Dr. Michaud we seem to have caught a glimpse of a whole new universe that we have been living in without knowing it. Like a blind man who begins, as they remove the bandage from his eyes, to catch his first glimmer of light, to perceive a dim and distorted vision of unknown realities all around him, so we stand, it seems, on the very verge of new and enormously important discoveries; discoveries that will change, it may well be, every supposed fact and every present idea and every condition of life in the world.

REFERENCES

Readers desirous of studying the details of the theories here described will find Dr. Perrin's ideas set forth in his monograph "Matière et Lumière" in the *Annales de Physique*, vol. 11, pages 5-108 (January, 1919), especially on pages 78 to 95. Dr. Michaud's theory of the cause of gravitation, as well as many other implications of the ultra-X-ray idea for which I have not had space in this article, was published in his pamphlet entitled "Rayonnement et Gravitation," 61 pages, Gautier-Villars et Cie., Paris, 1922. There is a brief review by Dr. Michaud himself in the *Revue générale des Sciences* for January 15, 1923. Dr. Millikan's experiments have not been published. They will be noted in POPULAR RADIO as soon as they appear. For information about X rays and gamma rays—a necessary starting point, of course, for study of the possible shorter waves—the best book is *X Rays* by G. W. C. Kaye, fourth edition, 320 pages, Longmans Green and Co., New York, 1923.

—The Author

Where Fortunes Await Radio Inventors

Unlimited opportunities lie before the radio fan—before the novice as well as the scientist—for solving some of the mysteries of radio phenomena. In the next issue of POPULAR RADIO Henry Woodhouse will point out just where these opportunities are.

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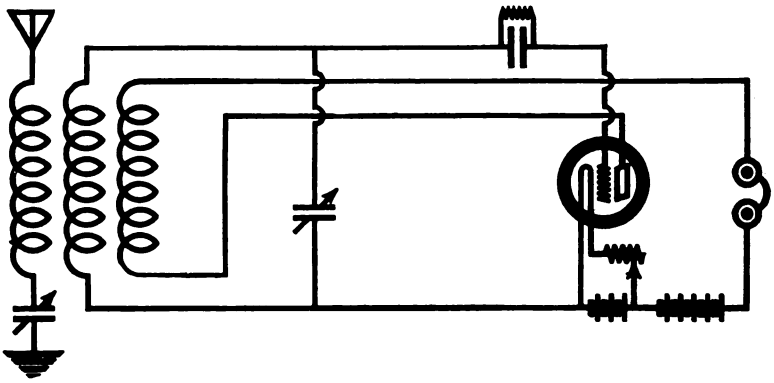

DO YOU KNOW WHAT THE ABOVE SYMBOLS MEAN?

Unless you do, you cannot understand the practical and useful hook-up drawings that constitute such a valuable part of this magazine. Read this article and learn how simple to understand these diagrams really are!

HOW TO
READ A DIAGRAM

PART I

THIS *article is written—and illustrated—for the very particular benefit of the radio fan who is unfamiliar with the common symbols used in the technical diagrams that explain radio circuits. A knowledge of these symbols is necessary to the understanding of "hook-up" drawings. In this two-part article this information is presented in the most simple and comprehensive form.* KEEP THIS ARTICLE FOR REFERENCE.

By ALBERT G. CRAIG

"WHERE may I obtain a 'picture-diagram' of the four-circuit tuner? I do not know how to read the regular diagrams."

This is one of the most frequent questions received by The Technical Service Bureau of this magazine.

It is evident that a large percentage of radio fans are unable to interpret the conventional, electric-circuit diagram. Rather than use the inferior picture method to bring home a circuit to the uninitiated, POPULAR RADIO has decided to show the radio fan how to master the standard diagram.

First of all, the student who wants to learn how to read a diagram must make himself familiar with the conventional symbols which are used in all hook-ups. Therefore, let us first consider the instruments that are most familiar in radio.

The following pages show pictures of the instrument, together with the standard symbol that represents it; also short descriptions of the instruments and their uses. These symbols should be memorized before the beginner undertakes to read a diagram.

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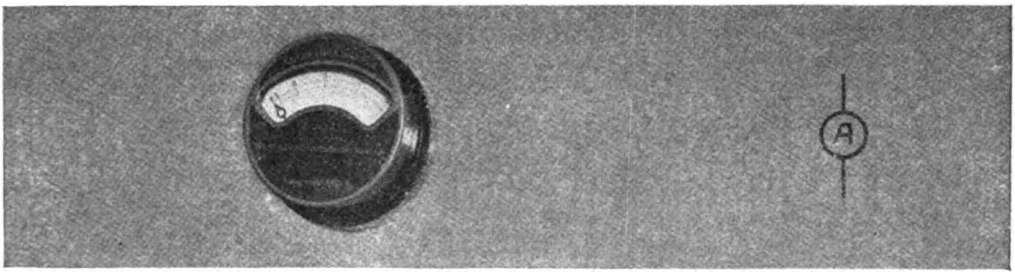
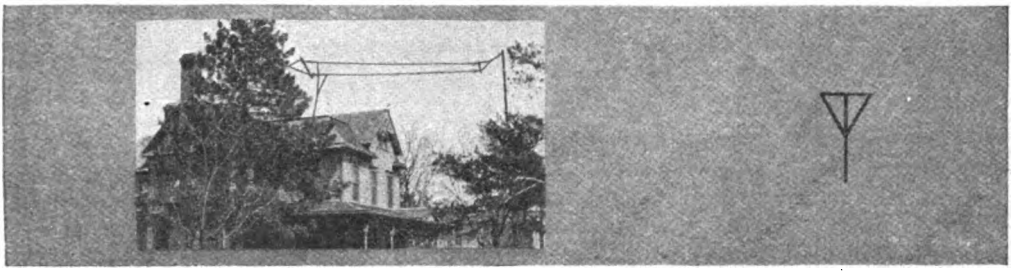
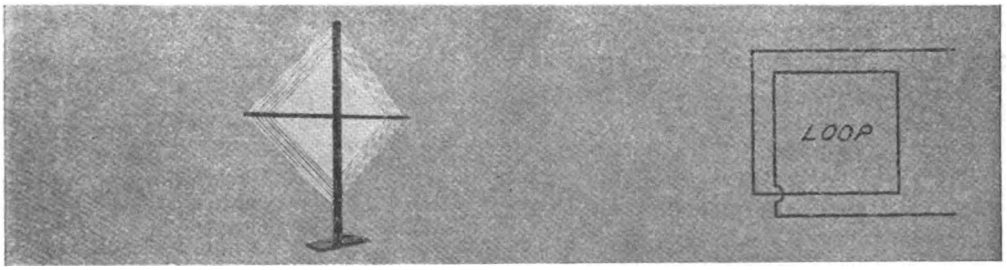


AMMETER—The ammeter is a device for measuring the current flowing in some particular circuit; for instance, it could be placed in the filament circuit of a vacuum tube to see how many amperes were being drawn from the storage battery. An instrument for smaller current values (the milliammeter) could be connected in the plate circuit of the vacuum tube to see how many thousandths of an ampere were being drawn from the "B" battery. An ammeter never measures how many amperes there are in the battery, but it does measure the number of amperes that some other instrument is drawing from the battery or whatever source of power we may have. The ammeter has two terminals and is always connected in series in the circuit; that is, one of the wires of the circuit is broken and the two resultant ends are connected to the two terminals of the ammeter.



ANTENNA—The most common type of antenna (and one that gives universal satisfaction for receiving) is the single-wire "L" type, approximately 100 feet long. It is insulated at each end, preferably with a glazed-porcelain antenna insulator, and the lead-in to the receiving set is taken off at one end. Number 14 seven-strand bare copper wire is most suitable for antenna wire because of its larger surface and greater strength than the solid wire of the same gauge. For transmitting, four parallel wires are often used to give greater radiating area; a wire joined to each of these is in turn connected to the single lead-in. As the multiple lead-ins always are joined to one common wire we may regard the antenna as having a single connection and thus it is shown in the diagrams.



LOOP ANTENNA—The regulation outdoor antenna always gives reception over greater distances and also louder signals than the loop on the same receiving set. However, circumstances may make the use of a loop necessary; in this case the amplification will have to be increased considerably over what would be necessary with the outdoor antenna. Two or three stages of rado-frequency amplification will be required in addition to the customary detector and two stages of audio-frequency amplification. Do not attempt to use a loop on the ordinary three-bulb regenerative set. For broadcast reception the loop antenna may consist of twelve turns of No. 18 wire wound in a square, two feet on a side, the turns being separated one-half inch. The loop antenna has two connections, although one of these may be arranged so that it can be cut in on different turns.

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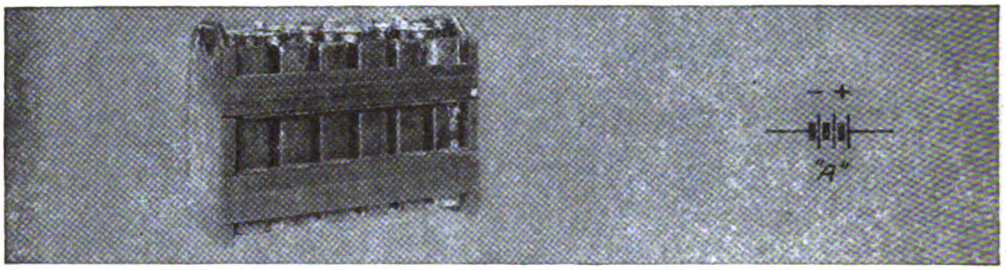
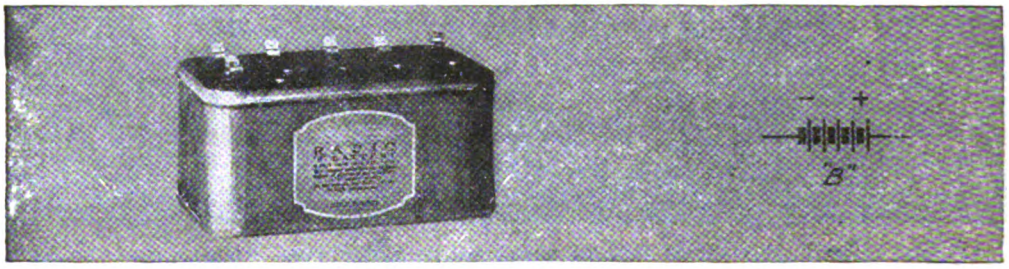
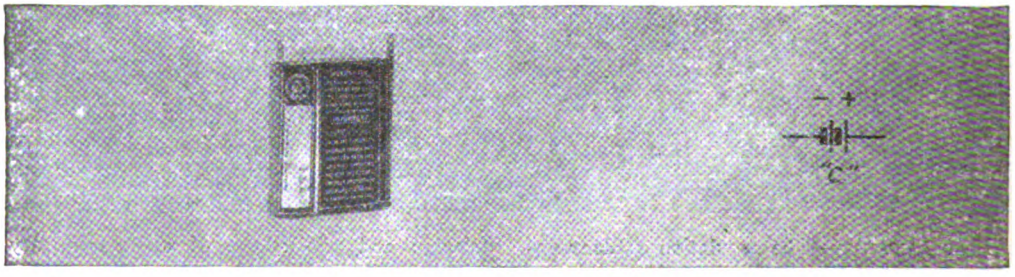


"A" Battery—Until recently the "A" or filament-lighting battery was almost universally of the storage type. It may be well to note here that the UV-201-a tube is primarily a storage-battery tube, and that it is not economical to operate more than one of these tubes on dry cells. However, the use of tubes, such as the UV-199 and WD-11, which operate on an "A" battery made up of dry cells, has increased materially in the last year or two. Although made up of several cells, the "A" battery has two main terminals which connect to the filament of the tube; one of these is positive and the other negative. Make sure that the voltage at these terminals is correct for the tubes you are using, and also that the "A" battery is capable of furnishing current for the number of tubes which you intend to use. Three WD-11 tubes should have three dry cells connected in parallel, for instance. One dry cell would have the same voltage but it could not furnish current for three tubes economically. By using three cells in parallel the current is divided between the three.



"B" Battery—The "B" battery is made up of a number of "flashlight" cells connected in series and sealed together in a convenient container, there being fifteen of the cells in the 22½-volt size and a correspondingly larger number in the higher-voltage batteries. The large-type "B" battery will prove more economical for a permanent set, while the smaller sizes have their points of advantage for portable sets. The detector battery is usually a 22½-volt, tapped type which gives any voltage in steps of 1½ volts from 16½ to 22½ volts for soft detector tubes which are critical to plate voltage. The amplifier "B" battery can be conveniently made up of 22½ or 45-volt blocks connected up in series to give the required voltage. The battery made up in this manner will have two outside or unconnected terminals, one positive and one negative, and these will form the connections to the set.



"C" Battery—With more than 67½ volts on the plate of the average tube it is advisable to connect a "C" battery in the grid circuit to bring the potential of the grid to the correct negative point with respect to the filament. Small flashlight cells of 3 to 4½ volts make good "C" batteries and are easy to obtain. To connect a "C" battery in an amplifying circuit, break the grid lead between the amplifying transformer and the filament, and connect the ends to the two terminals of the "C" battery, the negative side of the latter should be toward the transformer and grid. Another advantage of the "C" battery is that it cuts down the average plate current greatly and makes the "B" battery last much longer.

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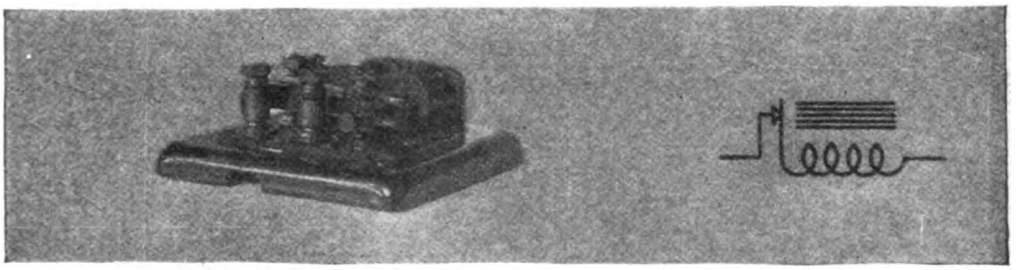
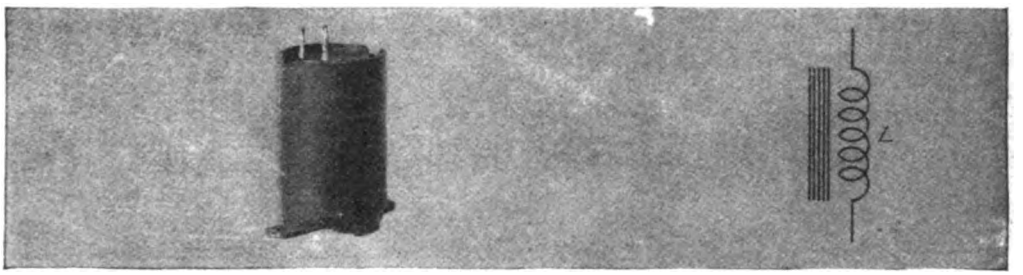
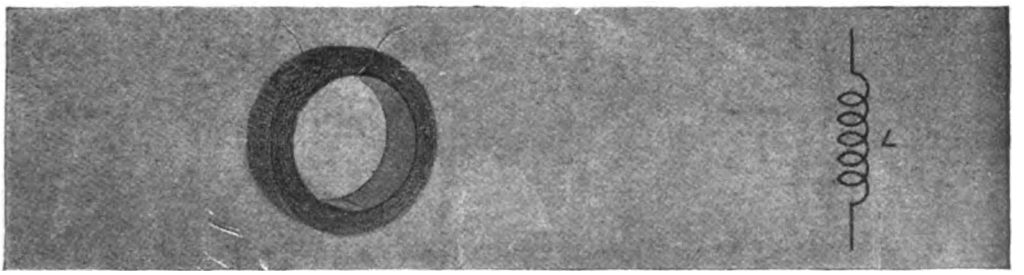


BUZZER—The chief uses of the buzzer in radio are for code practice and for testing out crystal detectors to find a sensitive spot. The buzzer for either of these purposes should (preferably) be one of the special high-frequency type. The note of an ordinary call buzzer is much too low. For code practice a buzzer, battery (dry cell) and a key are simply connected in series. For testing crystal-detector adjustment, a buzzer, battery, and a key or push button are connected as above, and in addition a wire is connected, from the binding post nearest the buzzer interrupter, to the ground lead of the receiving set.



AUDIO-FREQUENCY CHOKE COIL—The audio-frequency choke coil consists of an iron core with a continuous winding, and has two connections, one to each end of the winding. The choke coil has a tendency to smooth out variations in current as its magnetic field opposes all changes in the current. An example of this use is to steady the plate current of a transmitting tube by connecting one or more choke coils in series with the rectified supply. There is always a drop in voltage across a choke coil and this is used in choke-coil-coupled amplifiers. The choke coil is connected in the plate circuit of one tube and the drop across it used to operate the succeeding tube in the next stage of amplification.



RADIO-FREQUENCY CHOKE COIL—The uses of the radio-frequency choke coil are very similar to the audio-frequency choke coil except that it is constructed to operate at much higher frequencies and is therefore generally made with an air core. The coil shown in the illustration is an ordinary honeycomb coil, which type is usually satisfactory for radio-frequency choke-coil purposes. The radio-frequency choke consists of a single winding and has one connection at each end. Such a coil may be used in a low-power vacuum-tube transmitting set as a radio-frequency choke in the grid-leak circuit or in the plate circuit to keep the high-frequency energy from getting back into the power supply.

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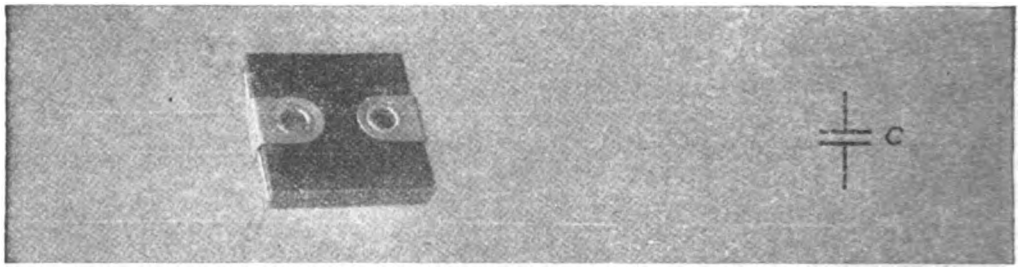
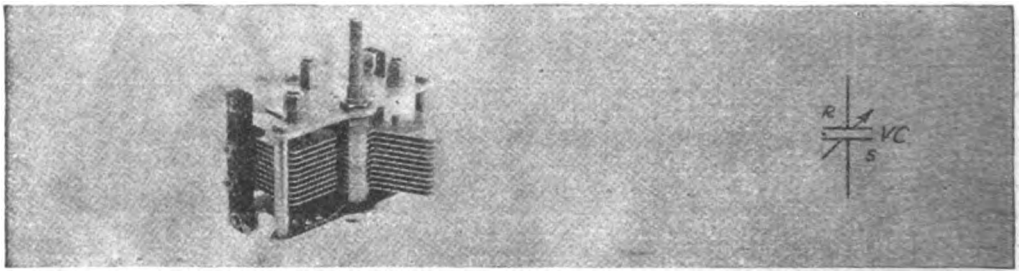
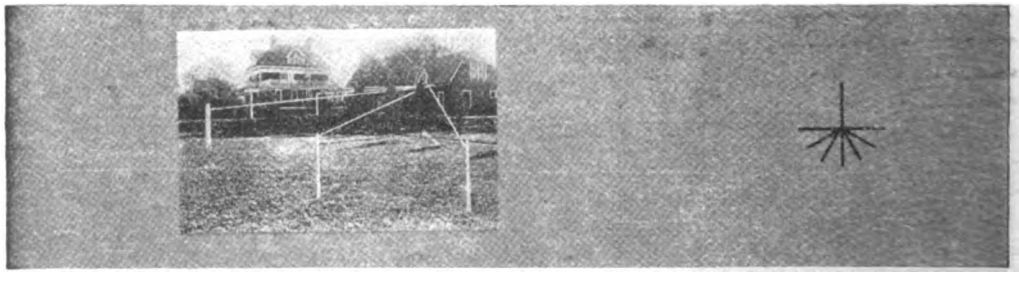


FIXED CONDENSER—The most satisfactory type of fixed condenser for receiving sets, and one that is comparatively inexpensive, is the small mica condenser of reliable make. As the amount of energy handled is extremely small, it is not advisable to use home-made condensers of doubtful quality. One of these small condensers of .00025 or .0005 mfd. capacity can often be connected in series with the antenna to cut down the wavelength if necessary. In places where some loss does not matter and where the cost of a mica condenser of such large size would be prohibitive, such as the filter condensers for transmitting sets, paper condensers are often used. The fixed condenser has fundamentally two metal surfaces which are separated by an insulating sheet, although the metal surfaces may be made up of a large number of sheets. There are two connections, one to each of the metal surfaces.



VARIABLE CONDENSER—The variable air condenser has become fairly well standardized in form; it consists of a number of stationary plates, closely spaced and connected together, and approximately the same number of rotary plates which are also connected together and which mesh between but do not touch the stationary plates. The condenser has two connections, one to the stationary plates and one to the rotary plates. Always connect the rotary plates to the part of the circuit which is nearest the ground potential to avoid "body-capacity" effects. The condenser should be well made *mechanically* and *electrically;* the bearings should fit well and preferably be of metal; and the stator and rotor should be separated by a good insulating material to avoid excessive dielectric loss.



COUNTERPOISE—When a ground connection is impossible or when a natural ground gives too high a wavelength on our transmitting set, we fall back on the counterpoise; this is placed below the antenna and far enough above ground to clear obstructions. The counterpoise may take the form of the antenna or it may be spread out fan shape. At any rate it should be well insulated just the same as an antenna; otherwise, if it should be grounded (even poorly) at some point, we defeat the purpose of the counterpoise which is to give a uniform electric stress over its entire area much the same as the stress between condenser plates. The wires of the counterpoise should be all connected and soldered together to form a single lead-in to the transmitting or receiving set.

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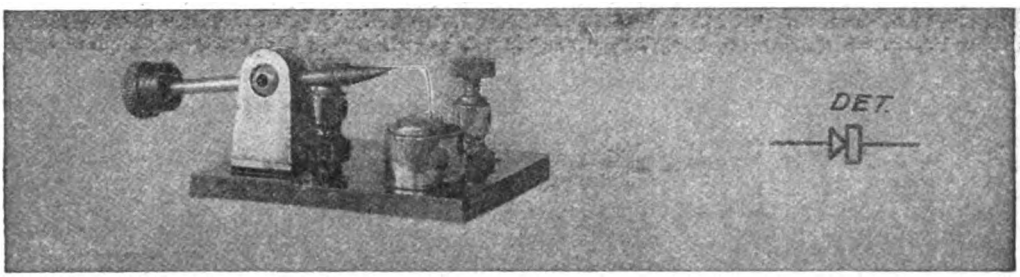
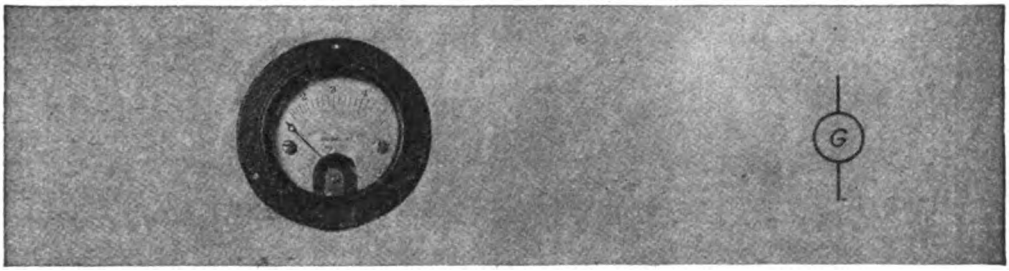
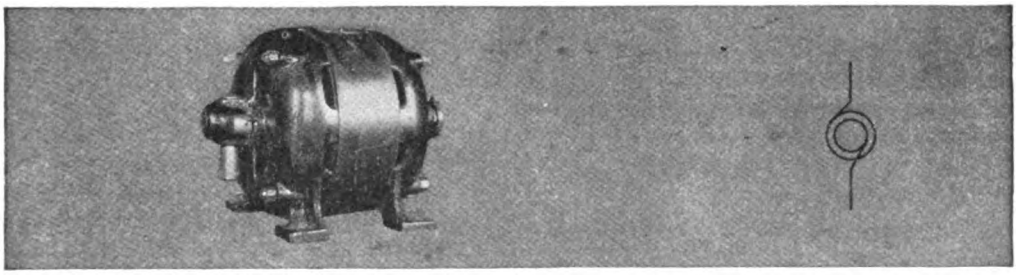


CRYSTAL DETECTOR—The crystal detector generally takes the form of a fine wire or "catwhisker" pressing lightly on some kind of mineral crystal; the common minerals are galena, silicon, pyrites, carborundum or one of the synthetic crystals. Within 15 to 25 miles of the large broadcasting stations the crystal set will give good, clear reception on the telephones; a loudspeaker cannot be used with a crystal set. In selecting a crystal detector see that it is so constructed mechanically that the entire surface of the crystal can be easily explored with the "catwhisker." There are two connections to the crystal detector, one to the "catwhisker" and one to the cup which holds the mineral.



GALVANOMETER—The galvanometer is a delicate instrument for indicating a small electric current, but is not used for measuring current. That is, it may be used to show when the current is minimum or maximum, but not the exact value of it. The galvanometer is useful in bridge-measurement work where it is necessary to compare unknown values of resistance, inductance or capacity with standards of the same. It can also be used for wavemeter work in radio. The galvanometer has two connecting terminals and there will always be shown two wires running to it in any circuit diagram.



A.C. GENERATOR OR MOTOR—The A.C. generator finds little use in radio work except in spark transmitters but the motor is often used as a source of power for motor-generator sets when the local electric supply is alternating current. The A.C. generator or motor frequently has three terminals in the larger sizes as three-phase distribution of power is more satisfactory than single phase. The single-phase motor is not inherently a self-starting device, and must have some sort of starting mechanism incorporated within it; on the other hand the three-phase motor *is* self-starting and is much more rugged. The single-phase motor has two terminals brought out to binding posts.

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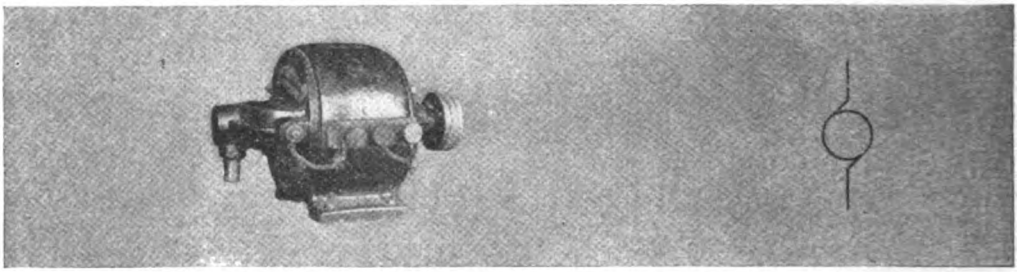
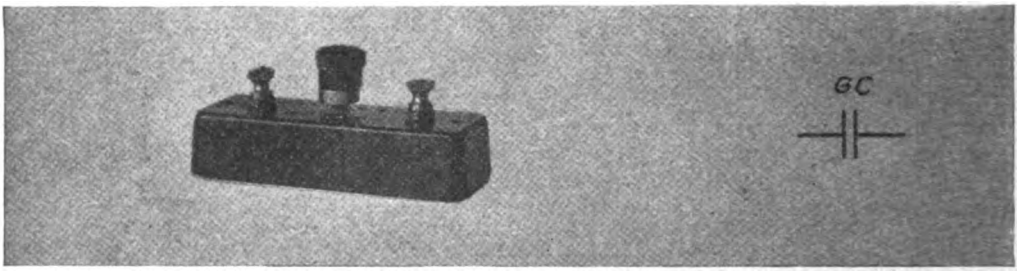
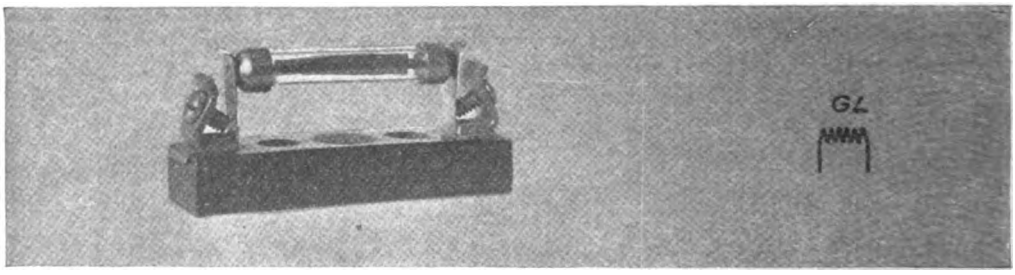


D.C. GENERATOR OR MOTOR—The D.C. generator is used in radio work to produce the high-voltage plate supply for the better class of transmitters. It also finds a use in stepping the voltage down for battery charging. The D.C. motor is used for power in the motor-generator set, for driving spark gaps, etc., when the local electric supply is direct current. There will usually be two connections for the generator and also two connections for the motor unless the latter is so powerful that it requires some sort of starting mechanism. The local electric company will have its own regulations about the sizes of motors requiring starters. The motor itself will have two external connections or terminals.



GRID CONDENSER—For the purpose of detection we must operate the tube at the knee of the "characteristic curve" by the use of a "C" battery or resort to the grid condenser, which isolates the grid and allows the negative charge on it to build up through several cycles instead of changing to positive at each half cycle as it would normally do. The grid-condenser method of detection is used in most receiving sets and the common value of the grid condenser is .00025 mfd. One of the small mica fixed condensers is just as good as something more expensive. However, do not try to economize by using a paper condenser at this point. The grid condenser has two leads.



GRID LEAK—With the grid-condenser method of detection some means must be provided to allow the negative charge on the grid of the tube to *leak off gradually;* otherwise the charge would build up until the tube was paralyzed. For this purpose a high-resistance path called the grid leak is connected between the grid and the filament; the value of the grid leak runs into the millions of ohms, 2 megohms (2,000,000 ohms) being a common value. While there may be some advantage in a variable grid leak, it is so difficult to find a good one, that the tubular type is perhaps the safest one to use. There are two connections to the grid leak, one to each end of the resistance unit.

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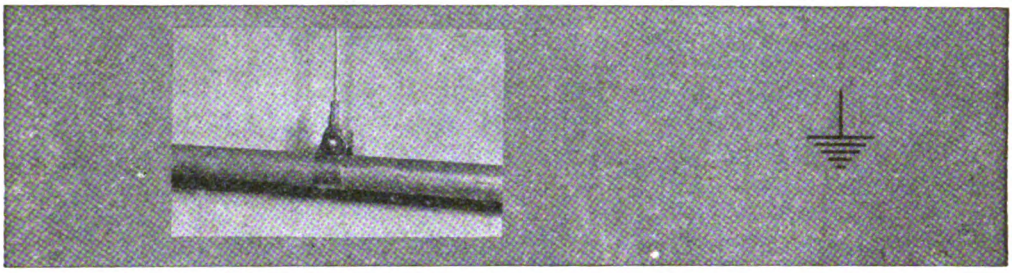
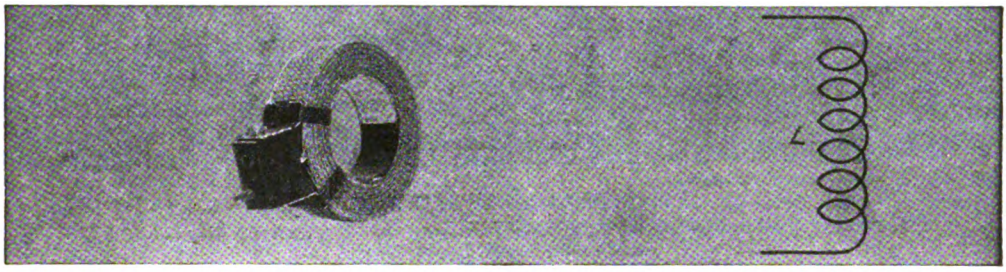
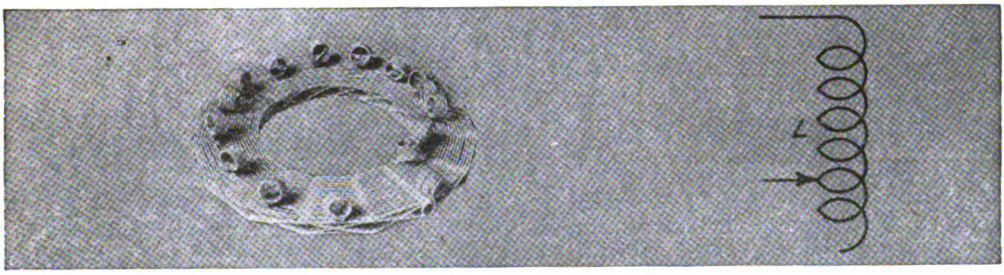


GROUND—Fortunately a good ground *is* available to most of us; the solution of this important problem is the ordinary water-piping system of the house. The ground wire may be soldered to a brass fitting, or one of the faucets, or it may be connected directly to the pipe itself by means of a ground clamp. The pipe should be brightened up with a file before connecting the ground clamp. If a ready-made ground is not at hand, a galvanized pipe driven in moist earth or a buried copper sheet is the best substitute. There is a single lead to the ground connection and the size of this should not be smaller than No. 14 copper wire.



FIXED INDUCTANCE—The fixed inductance or coil is a continuous winding with two connections, one at the beginning and one at the end. It may take the form of the single-layer coil, bank-wound coil, spiderweb coil, honeycomb coil, etc. The purpose of the various forms of winding is to decrease the distributed capacity of the coil; such inherent capacity acts much the same as a fixed condenser across the coil and this gives the system a natural wavelength, which is an undesirable condition since we usually wish to control the wavelength by means of a variable condenser connected across the coil. The honeycomb coil is especially useful for receiving the long wavelengths, while the other forms of winding are more widely employed on the short and medium wavelengths.



VARIABLE INDUCTANCE—The variable inductance is merely a coil with provisions for using a part or the whole of it. There are two fundamental connections; one usually goes to the end of the coil and the other to a slider, clip, or inductance switch. If an inductance switch is used, taps are taken off the coil five to ten turns apart and connected to switch points. A switch arm makes contact with any one of these points, thus cutting in more or less of the coil. Sometimes two switches are provided at opposite ends of the coil, one for *tens of turns* and one for *single turns*. Then the two fundamental connections are to the two switch arms. The old two-slide tuning coil was a little different, in that it had one fixed connection at the end, and *also* two sliders, one for the primary circuit and one for varying the inductance included in the secondary circuit.

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From a photograph made for POPULAR RADIO

THE COMPLETED SET

FIGURE 1: *The author shows how to adjust the crystal detector while rotating the switch that controls the tuning.*

HOW TO BUILD

AN EFFICIENT CRYSTAL RECEIVER

For local reception, the crystal set is still the simplest that will produce satisfactory results. Here is a re-creation of the famous Bureau of Standards receiver, brought up to date with a suitable wavelength range. The parts cost about $5.00 (exclusive of the phones) and the approximate reception range is 15 miles.

By MORRIS S. STROCK

IN recent months the radio broadcasting services have been greatly improved. This development has been marked by a reduction of interference through the new assignment of wavelengths, a more uniform distribution of stations transmitting good musical programs (this includes the relaying of programs by wire before broadcasting) and a tendency for mediocre stations to discontinue transmission.

In the large communities there are now many thousands of people within a few miles of the Class B stations; from them comes a demand for simple receiving apparatus that requires a small monetary outlay. For this purpose a crystal set will give practically perfect reception.

A crystal set may be of rather

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elaborate construction or it may be very simple without reducing its efficiency. Its cost is then much less than a set equipped with a low-voltage tube. Other points, often overlooked, are clearness of signal, absence of distortion, and no operating cost. Although the crystal is a relatively insensitive device, there is no justification in statements frequently made in radio articles, which give the impression that there is a definite limit to its receiving range. From a low-power broadcast station the reliable receiving range of a crystal set is, say five miles; in winter the same set may receive high-power stations from a distance of three or four hundred miles.

This article describes a crystal set of satisfactory performance. All structural details are given so that one need not be in doubt as to dimensions. Attention is called to the importance of good mechanical design. This requirement includes convenience of adjustment, rigid connections, permanent contacts, light, stable contact of the fine wire on the crystal, elimination of jarring and vibration from the tuning controls, and protection of parts from injury.

The parts of the set are arranged so that the connecting wires will be short and direct, and losses from unused turns on the tuning inductor have been reduced by cutting down the total number of turns. A variable condenser or phone condenser is not used. The former sometimes gives a little better selectivity but at the expense of signal strength; the latter is not necessary for broadcast reception. There is no objection to the use of wood for a switch panel. Tests show that there is less power loss in dry wood at radio frequencies than in the average insulating material used in radio panels.

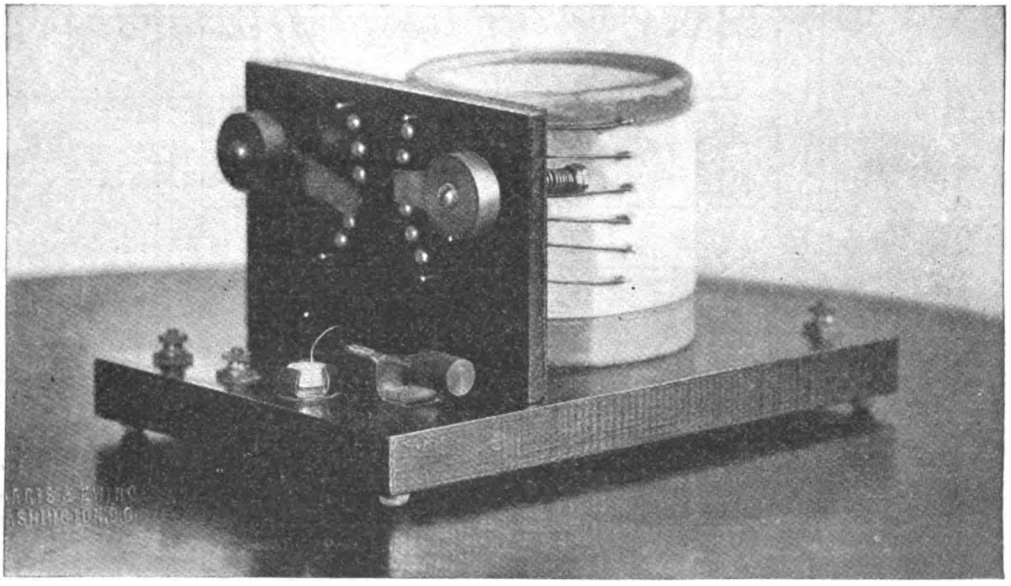
Parts and Material

The completed set is shown in operation in Figure 1. Figure 2 is a photograph of the set with cover removed. Figure 3 is a plan drawing and shows the parts and wiring. The list below names the parts used and gives the material required to make them.

A. BASE.

Required:

One piece of seasoned wood, 8 by 5½ by ¾ inches;
four rubber-headed tacks.



THE COMPLETED SET WITH THE COVER REMOVED

FIGURE 2: *This shows what a neat-looking job can be made of the set if the experimenter takes the trouble to make every part as specified in this article.*

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B. Switch Panel.
Required:
One piece of seasoned wood, 5¼ by 3½ by ½ inches; three No. 8 wood screws, 1½ inches long.

C. Cover (top removed).
Required:
Four pieces of seasoned wood, ¼-inch thick;
one piece, 5½ by 5⅛ inches;
two pieces, 4⅝ by 3½ inches;
one piece, 4¾ by 3½ inches;
brads or small screws.

D. Tuning Inductance.
Required:
One one-pint carboard carton;
two ounces No. 24 dcc copper wire.

E. Tap Switches.
Required:
No. 24 (B. and S.) gauge spring brass sheet, 1 by 2 inches;
two knobs cut from one-inch fiber rod;
18 inches No. 20 (B. and S.) gauge piano wire.
two 8-32 brass machine screws 2 inches long;

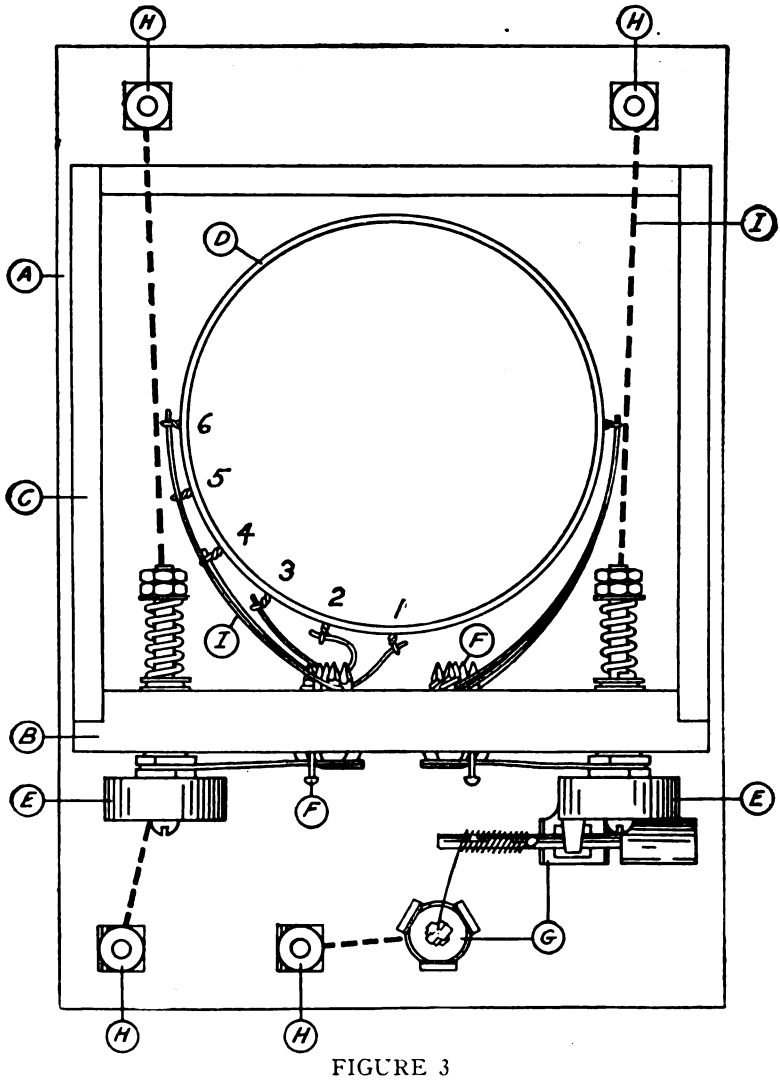

FIGURE 3

The working drawing of the set. This layout diagram shows the relative positions for all the instruments, as seen from above. The parts are designated by letters which reappear in the text and list of parts.

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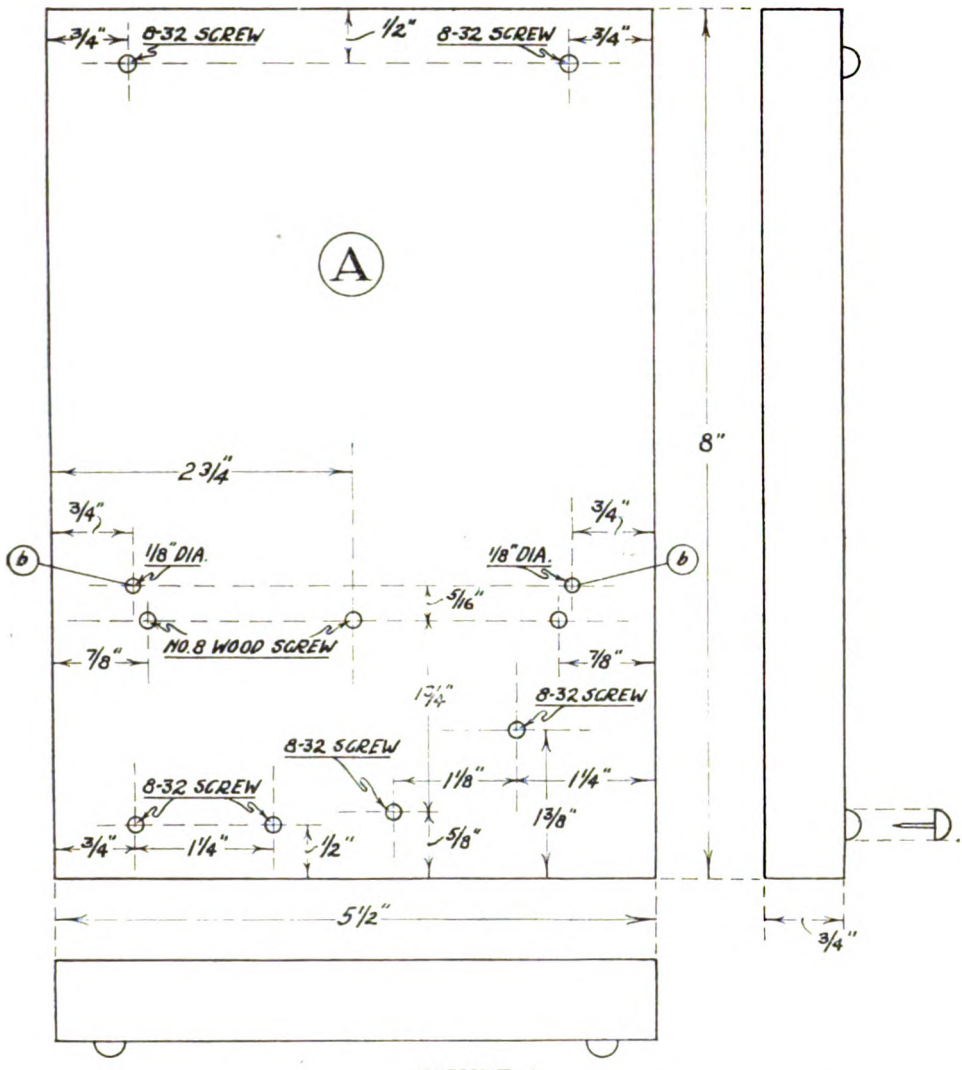

FIGURE 4

The dimensions of the base and the drilling plan. This drawing gives the front, side and top views of the base, together with the drilling data for the holes for the screws that are used to mount the instruments and binding posts.

eight 8-32 brass washers;
four 8-32 square brass nuts;
four 8-32 brass hexagon nuts.

F. Switch Points and Stops.
Required:
12 brass pins 1/8 to 3/32 of an inch in diameter and 3/4-inch long;
four small brass pins, 1/2-inch long.

G. Crystal Detector.
Required:
One galena crystal mounted in a block of Wood's metal 1/2-inch in diameter and 1/4-inch thick;
No. 24 (B. and S.) gauge spring brass sheet 2 by 2 1/4 inches;
eight inches of fine springy wire;
one 3/32-inch brass rod two inches long;
one 3/8-inch fiber rod 5/8-inch long;
two 8-32 brass machine screws one-inch long;
four 8-32 brass washers;
two 8-32 square brass nuts.

H. Binding Posts.
Required:
Four 8-32 brass machine screws, 1 1/4 inches long;
four 8-32 square brass nuts;
four 8-32 thumb nuts from dry cells;
eight 8-32 brass washers.

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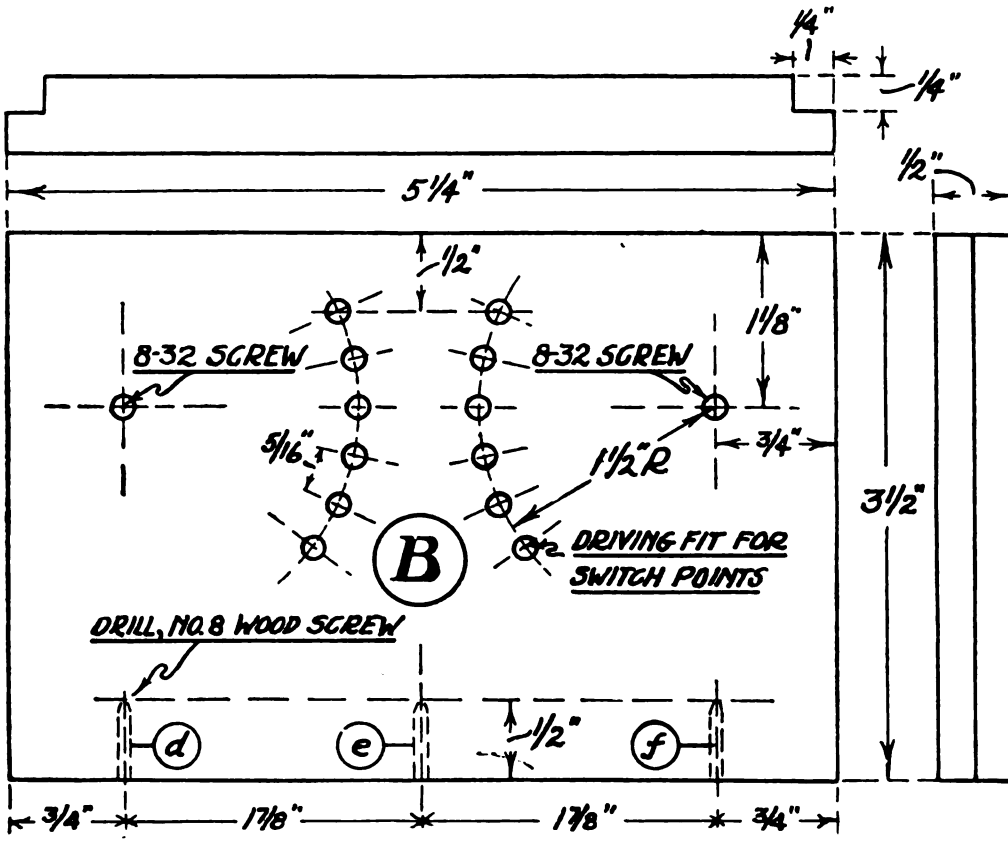

FIGURE 5

The dimensions of the switch panel and the drilling plan. This drawing gives the top, front and side views of the switch panel, together with the drilling data.

I. Connecting Wire.
Required:
Six feet No. 20 bare copper wire.

J. Miscellaneous:
Solder, *non-corrosive* soldering flux, stain and varnish (free from carbon pigment).

Construction

A. Base (Figure 4). All dimensions are given in the drawing.

B. Switch Panel (Figure 5). The spacing of the holes on the arcs is important to insure smooth operation of switches when switch points and switch blades are made as specified. Before the holes are drilled in the base and switch panel, these parts and the cover should be given a suitable finish. A dark finish will harmonize well with the exposed metal parts.

C. Cover (Figure 6). All dimensions are given in the drawing.

D. Tuning Inductance (Figure 7). This is made by winding wire on a one-pint cardboard carton, which as purchased, will be too long for the space requirements of the set. It is shortened to the dimensions shown in Figure 7a by cutting off a ring from the open end and also from the cover, and is here shown bottom side up with cover in place. The carton is wound with 76 turns of No. 24 dcc wire, starting with two small holes, b and e, and winding in the direction shown by the arrow. The wire fills the space between b, and the edge of the cover. In Figure 7 is shown the completed tuning inductance which has two terminals and ten intermediate taps. The terminals are made by forming the bare end of the wire into a small eye as shown. The intermediate taps are formed, while winding, by baring a ½-inch length of wire and twisting this into a small loop. The inductance may be dried in a warm oven.

E. Tap Switches (Figure 8). A completed tap switch is shown in Figure 8. Two switch blades are cut from No. 24 spring brass sheet, as shown in Figure 8a, with the grain of the metal running the long way. The end widths of switch blades are important and the edges of the blades must be bent up as shown, for smooth operation. Two knobs are cut from a fiber rod as shown at e, Figure 8. Two springs, as shown at b, Figure 8, are formed by wrap-

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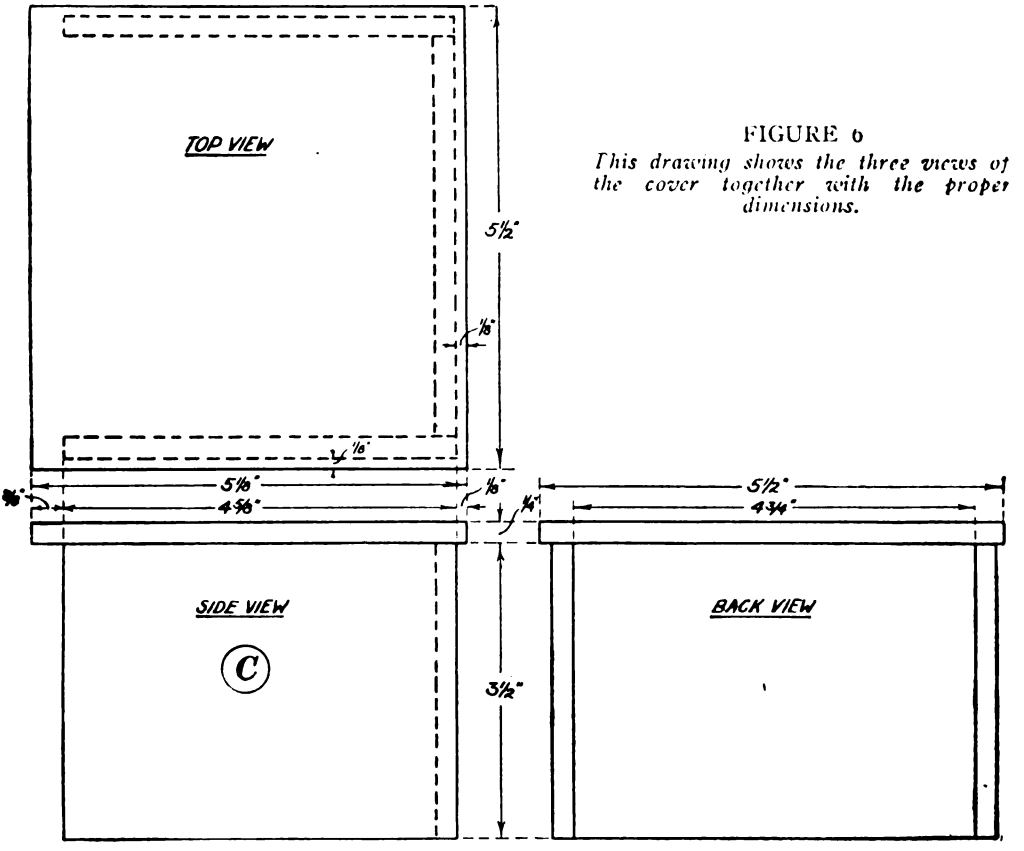

FIGURE 6

This drawing shows the three views of the cover together with the proper dimensions.

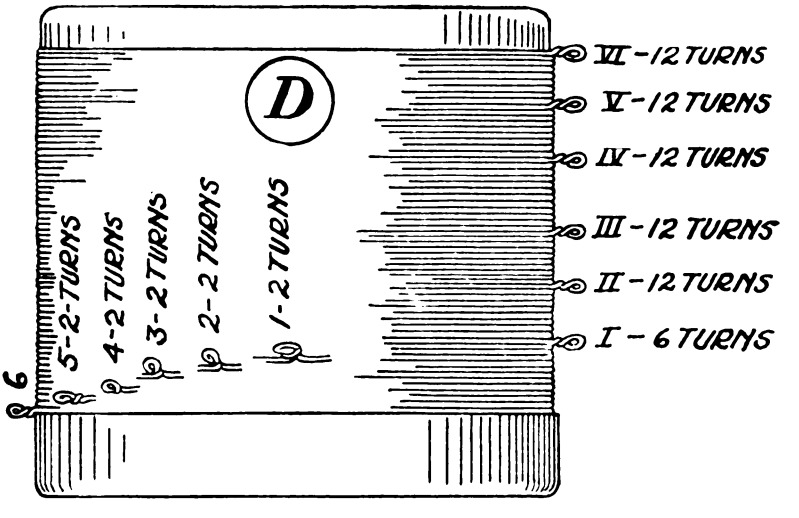

FIGURE 7

The completed inductance coil made on a pint-size container. This drawing shows the correct way to make the taps with the spacing between the taps indicated.

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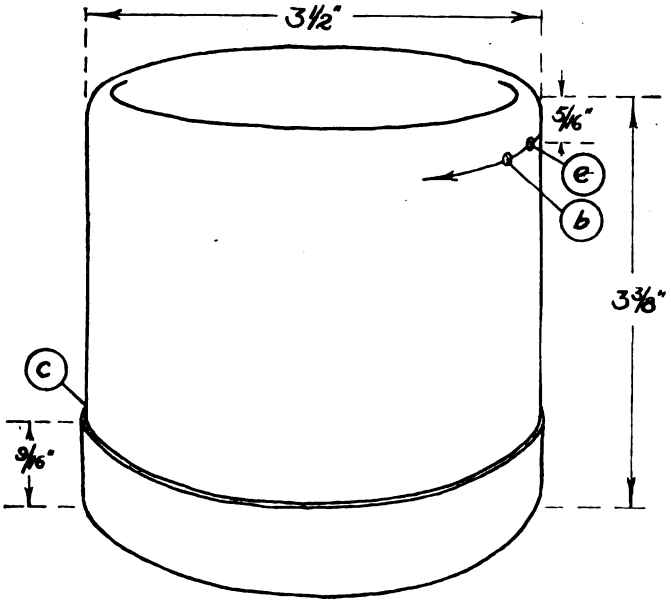

FIGURE 7A

How the container should be shortened by cutting off the end. This sketch gives the dimensions to which the tube should be cut down before starting the actual winding of the coil.

ping 10 turns of No. 20 piano wire around a 3/16-inch rod clamped in a vise. The switch is assembled upon an 8-32 brass machine screw c, shown in Figure 8.

F. Switch Points and Stops (Figure 9). The switch points are made from 12 brass pins with heads surfaced off with a file or in a lathe. This work requires accuracy to insure smooth operation of switch blades. The switch stops are made from four small brass pins.

G. Crystal Detector (Figure 10). In Figure 10 are shown the assembled parts of the detector. These are: a clip b, holding a mounted crystal c; an 8-32 screw d, and nut e; a fine wire (catwhisker) f, wrapped around a rod g, and secured by a drop of solder h; a knob i; a rod-holder j; an 8-32 screw k, and a nut m.

The clip is cut and filed from No. 24 spring brass sheet as shown in Figure 10a, and bent into the shape shown in Figure 10. All brass sheet must be bent with caution, the bends being made slowly and kept well rounded.

The catwhisker is an 8-inch length of fine springy wire wrapped 20 times evenly around the rod g, and secured by a drop of solder h, so positioned that when the rod is placed in the holder the lateral movement will be equal to the diameter of the crystal. The fiber knob i, is forced on the other end of the rod.

In Figure 10b are shown the dimensions of the rod holder, cut and filed from spring brass sheet, so that the grain of the metal runs with the narrow tongue. When bent carefully into shape it appears as shown at j, Figure 10.

H. Binding Posts (Figure 11). Each binding post is made up of an 8-32 brass screw, two washers, square brass nut and a thumb nut taken from a dry cell. A groove b, is filed in two of the nuts to facilitate connections of telephone-receiver terminals.

How to Assemble the Set

Four rubber-headed tacks are driven into the corners of the bottom of the base as indicated in Figure 4. The panel (Figure 5) is laid face up on two supporting strips and the 12 switch points are forced into the holes, caution being observed to have the surfaces of all the points in the same plane.

The tap switches are placed in position as shown in Figures 3 and 8. The switch blades are bent as shown by the dotted lines, and when forced down upon the switch points by the spring b, final adjustments are made to secure smoothness of operation. The nuts f and k, are then locked.

The panel (Figure 5) is mounted by three wood screws passing through the base and into the holes d, e, and f. It then appears as shown in Figure 3.

The detector parts (shown in Figure 10) are loosely mounted—in the positions shown in Figure 3—the screw d, being cut off so that it will not project through the nuts. The four binding posts—shown in Figure 11—are then loosely inserted in the base (Figure 3). Connecting wires—shown in Figure 3—of No. 20 wire are run from the two rear binding posts up through two holes b (Figure 4) in the base, looped around and forced between the washers

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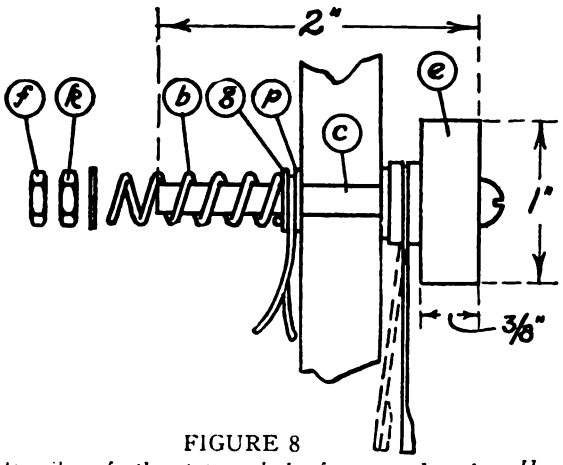

FIGURE 8

Details of the tap switch for wavelength control.

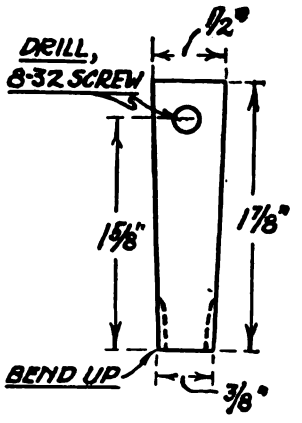

FIGURE 8A

How to cut out, drill and bend the switch blades.

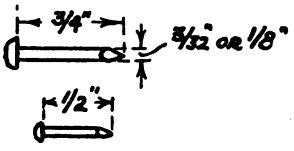

FIGURE 9

The dimensions for the switch points and stops.

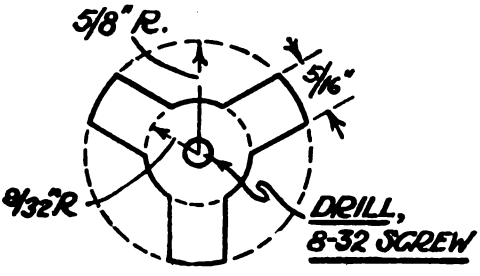

FIGURE 10A

How to drill and bend the clip for holding the crystal.

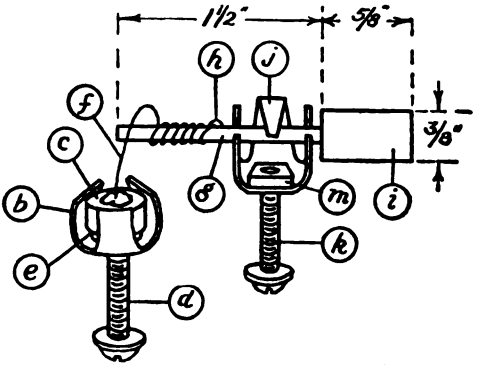

FIGURE 10

The complete detector assembly, showing the general arrangement of all the parts used.

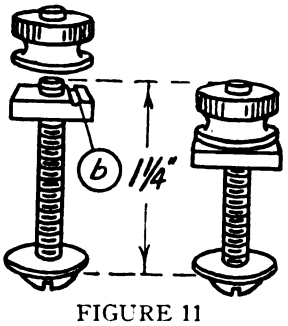

FIGURE 11

Sizes for the binding posts.

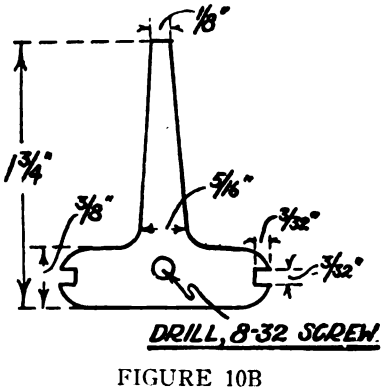

FIGURE 10B

The way to make the rod holder is shown here with the dimensions for drilling and shaping.

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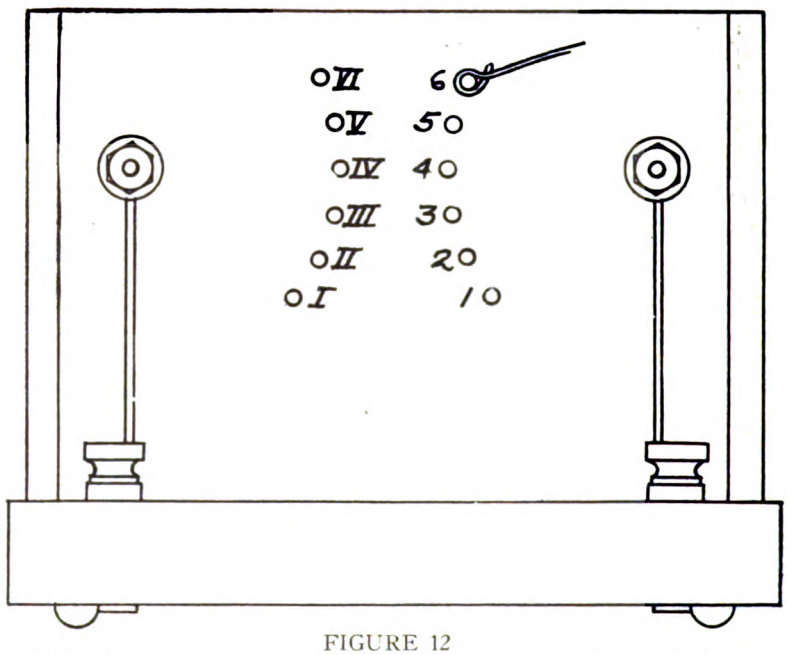

FIGURE 12

Assembling the panels and the switch points and binding posts. This is a view from the rear and shows how the switch points are forced into the holes drilled for them in the upright panel, and how the wire taps are connected one to each switch point. The two switch blades are connected by a wire to the two binding posts on the base.

g and p (Figures 3 and 8) back down through the base and thence connected to the left phone binding post and the screw securing the rod holder in place. One short length of wire connects the remaining phone binding post and the crystal. The wire ends are secured by looping around between the washers on the bottom of the base; the screws are then tightened until the nuts on top of the base become rigid. Before the crystal clip and rod holder are permanently secured in place a burr is formed on the edges which come in contact with the wood by bending down these edges slightly.

Twelve short lengths of No. 20 bare copper wire should be soldered to the switch points where they project through the rear of the panel as shown in Figure 12.

The cover of the tuning inductance is tacked to the base equally distant from the edges and one-half inch from the rear of the panel. The inductance is fitted into the cover and secured by glue or varnish. The location for the taps will be determined by referring to Figure 3. Tap 1 (Figures 3, 7, and 12), will be directly below switch point 1 (Figure 12). The twelve wires from the switch points (Figures 3 and 12) are formed into neat curves, cut off to the proper length so that they may just be inserted in the inductance taps, and soldered in place using a very small soldering iron and a small amount of solder. Switch points in Figure 12 are numbered to correspond to taps in Figure 7. Point 1, being most inaccessible is first soldered to tap 1.

The parts of the cover, shown in Figure 6, are fastened together with glue and brads (or small screws) forming the completed cover which gives the set the finished appearance shown in Figure 1.

How to Operate the Set

The antenna is connected to the right-hand rear binding post. The ground wire is connected to the left-hand rear binding post, thus bringing the phones near ground potential. The antenna wire is shown in Figure 1. An inspection is made of the mounted crystal to see that it is held firmly by the clip; the extreme end of the catwhisker should then be given a sharp diagonal cut with a pair of scissors.

Adjusting the set involves two operations:
(1) Securing a sensitive contact of the catwhisker;
(2) Tuning.

By means of the knob the point of the catwhisker is brought down lightly upon the crystal. The right switch blade is rotated slowly over its points and at each new position the left switch blade is rotated two or three times over its points. This operation explores all the inductance turns, two at a time. If there is no response in the phones, operations (1) and (2) are repeated and local stations should now be heard. Finally, when the switches are set at the most advantageous position, a more sensitive adjustment of the detector may be obtained by lifting the cat-

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whisker and replacing lightly in various positions.

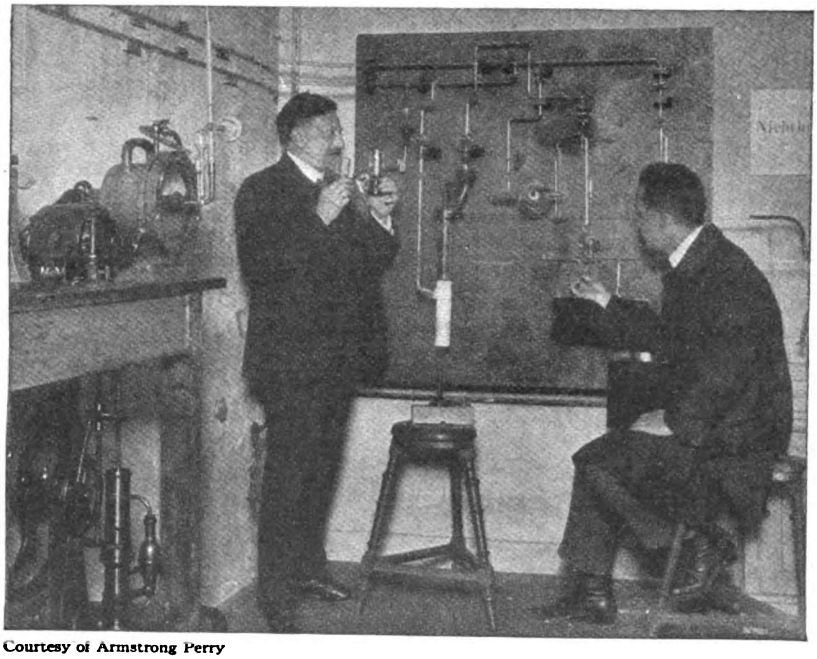
As the switch blades are moved *up* the wavelength of the set is increased. When the left switch advances one point the tuning inductance turns are increased by two. When this switch reaches point 6 the turns are increased somewhat less than two by advancing the right switch one point and returning the left switch to point 1. Thus, in tuning, as the successive turns are cut in, that part of the process which requires shifting both switches, will give a smaller wavelength increase.

The antenna may be a single wire 80 feet long (or two wires 50 feet long) and about 30 feet high. If the antenna is too large the number of inductance turns required to receive the shorter broadcast wavelengths will be so reduced that the signal strength will also be decreased. In this connection, most effective results will be obtained by keeping the antenna clear of obstructions and adjusting its length until signals from the longest wave broadcast station are heard with the switches near the upper points. With this set the writer obtained good recepton from a Class B station two and a half miles distant, using a small indoor antenna, but such an antenna is not recommended for a crystal set.

A telephone head-set having a resistance of 2,000 ohms or more will give good results. Reception from a considerable distance will be more satisfactory if phones priced above the conventional standard be used.

As the crystal is the life of the set, emphasis is laid upon the importance of securing a good one, which should not only be sensitive to weak signals, but which should give response from local stations at most random positions of the catwhisker. The crystal may be kept covered when the set is not in use, but after a time its surface may become insensitive. It may be cleaned with alcohol or soap and water and a clean brush.

The input terminals of a two-step, audio-frequency amplifier may be connected to the phone binding posts of this set and good volume of sound will be obtained from local stations. The use of the crystal detector gives signals of maximum clearness.



Courtesy of Armstrong Perry

VACUUM TUBES THAT SELL FOR 50 CENTS

Dr. Max Reithoffer of the government Electrotechnical Institute of Vienna is holding two of the Austrian vacuum tubes which are efficient detectors and amplifiers and which sell in that country for an equivalent of about 50 cents in American money. The apparatus in the lower left-hand part of the picture are the mechanical pumps used in the evacuating system for making these foreign tubes.

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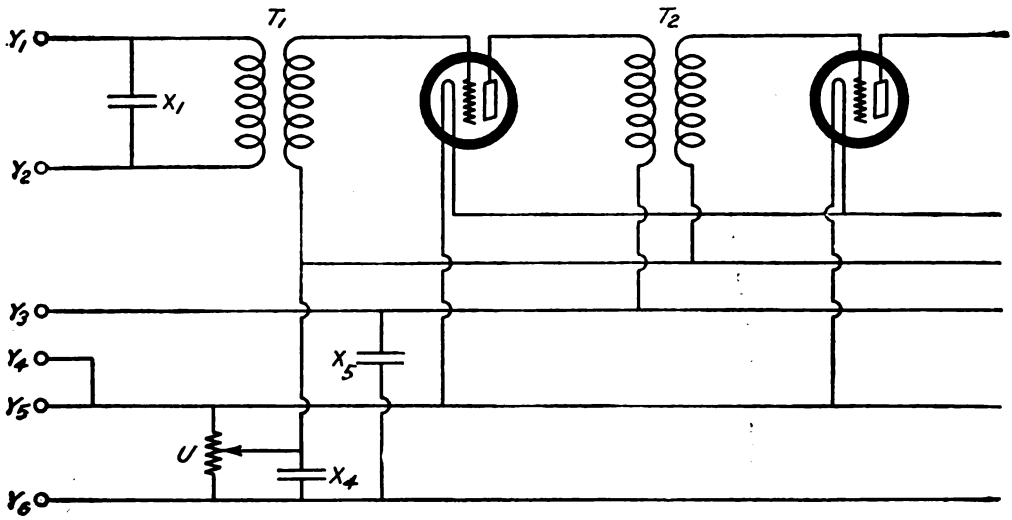

HOW TO BUILD THE NEW REGENERATIVE

Super-heterodyne Receiver

PART II

Part 1 of this article told how to make the oscillator for the super-heterodyne; it also gave an outline of the salient points of this type of receiver and described what it was and what it would do. Some of the new points involved in the amplifier unit are described in detail in the following article.

By LAURENCE M. COCKADAY, R. E.

FIRST of all, when they started work on this set, the designers tested out the various makes of transformers for radio frequencies between 2,000 and 6,000 meters. After long experimentation, they decided that there would be a distinct advantage in a transformer which would not involve the use of an iron core. It was decided that they needed a transformer that would be *sharply* tuned to *one particular wavelength* to which all incoming signals could be heterodyned.

This, of course, would insure much sharper tuning, in the set as a whole, than would be possible with a radio-frequency transformer which responded to signals over a relatively wide band of wavelengths.

After still more experimentation with air-core transformers which were built up with variations in the turn ratios, variations in the fundamental wavelengths, variations in the magnetic coupling, and variations in the resistance of coils (this involved many trials with windings of different sizes of wire) it was decided to use a transformer that was extremely sharply tuned on 3,000 meters. This was found better than the somewhat higher wavelengths more generally used in super-heterodyne amplifiers in that the possibility of cutting out some of the side bands due to critical tuning was less than at the higher wavelengths. This wavelength also was found to be relatively free from interference. (The reader will note that POPULAR RADIO does not describe how to make these transformers or any other

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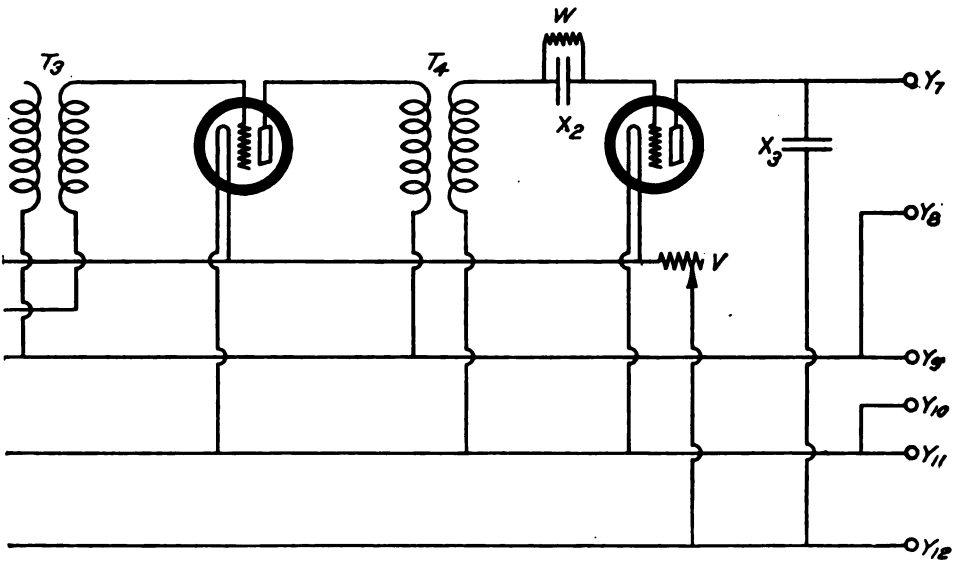

THE ELECTRICAL WIRING DIAGRAM FOR THE AMPLIFIER AND DETECTOR

FIGURE 1: *By following this circuit, the amateur experimenter may be sure of obtaining the proper connections for the instruments. The parts are designated by the same letters that appear in the other diagrams and the text.*

parts of radio apparatus which it considers beyond the scope of the amateur experimenter's handiwork. It is much better that he should buy the parts and be sure of satisfaction in his experiments than that he should waste a lot of time and energy and finally get unsatisfactory results.)

Then there was the consideration of a suitable means for coupling the output circuits of the tuner* and the oscillator† to the radio-frequency amplifier. In most amplifiers which are broadly tuned, the input circuits are usually tuned fairly sharply by means of two honeycomb coils placed in inductive relation and shunted by two variable condensers. In adjusting such a set the proper coupling had to be found by experiment; then the two condensers had to be adjusted to the best resonance point of the radio-frequency transformers. This of course helped in sharpening up the operation of the set, but it added the adjustments of coupling and double-circuit tuning to the set.

In the amplifier described in this article the input transformer is designed with a high step-up voltage ratio; at the same time, by shunting the primary coil with a fixed condenser of the proper capacity, the correct wavelength (corresponding to the wavelength of the other transformers) is automatically adjusted, thus eliminating all the adjustments that have heretofore been regarded as necessary.

The amplifier contains three steps of tuned-radio-frequency amplification which is fixed in wavelength and also the detector (vacuum tube). It is a simple matter to build the unit and it is also a simple matter to operate it. There are only two knobs on the set; a regeneration control (potentiometer) which has to be adjusted only once, and one rheostat which controls the filament of all four tubes.

The exact electrical wiring diagram is shown in Figure 1.

*See POPULAR RADIO for September, 1923.
†See POPULAR RADIO for November, 1923.

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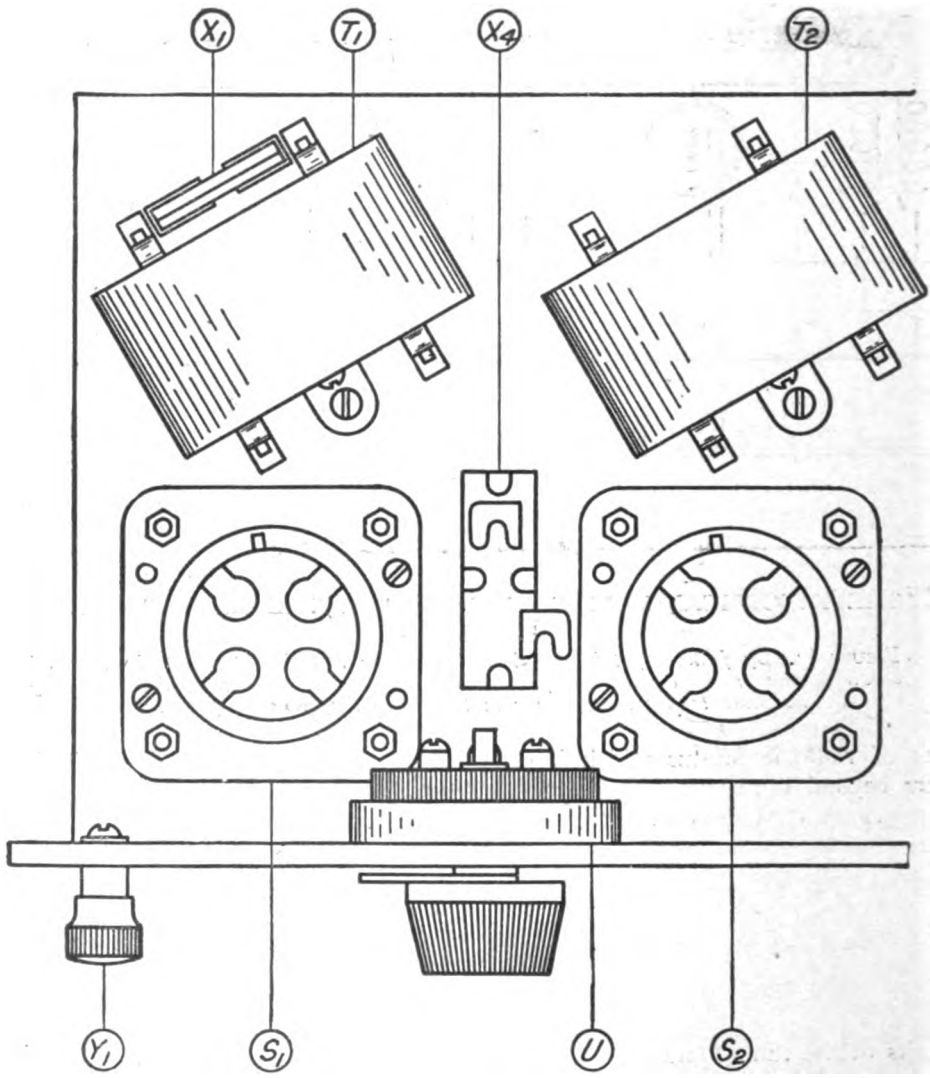

THE WORKING DRAWING FOR ASSEMBLING THE AMPLIFIER UNIT

FIGURE 2: *This layout shows the spacings for the instruments, the transformers, the sockets, rheostats, condensers, potentiometer, and the two rows of binding posts.*

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and the list of parts below.

¶ *The list of parts here given includes the exact instruments used in the particular set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

S1 to S4—vacuum-tube sockets;
T1 to T4—four Haynes-Griffin transformers, one input and three radio-frequency transformers, 3,000 meters;
U—Fada potentiometer, 200 ohms;
V—Fada filament rheostat, 6 ohms;
W—tubular grid leak, 2 megohms;
X1—Dubilier mica condenser, .0005 mfd.;
X2—Dubilier mica condenser, .00025 mfd.;
X3—Dubilier mica condenser, .002 mfd.;

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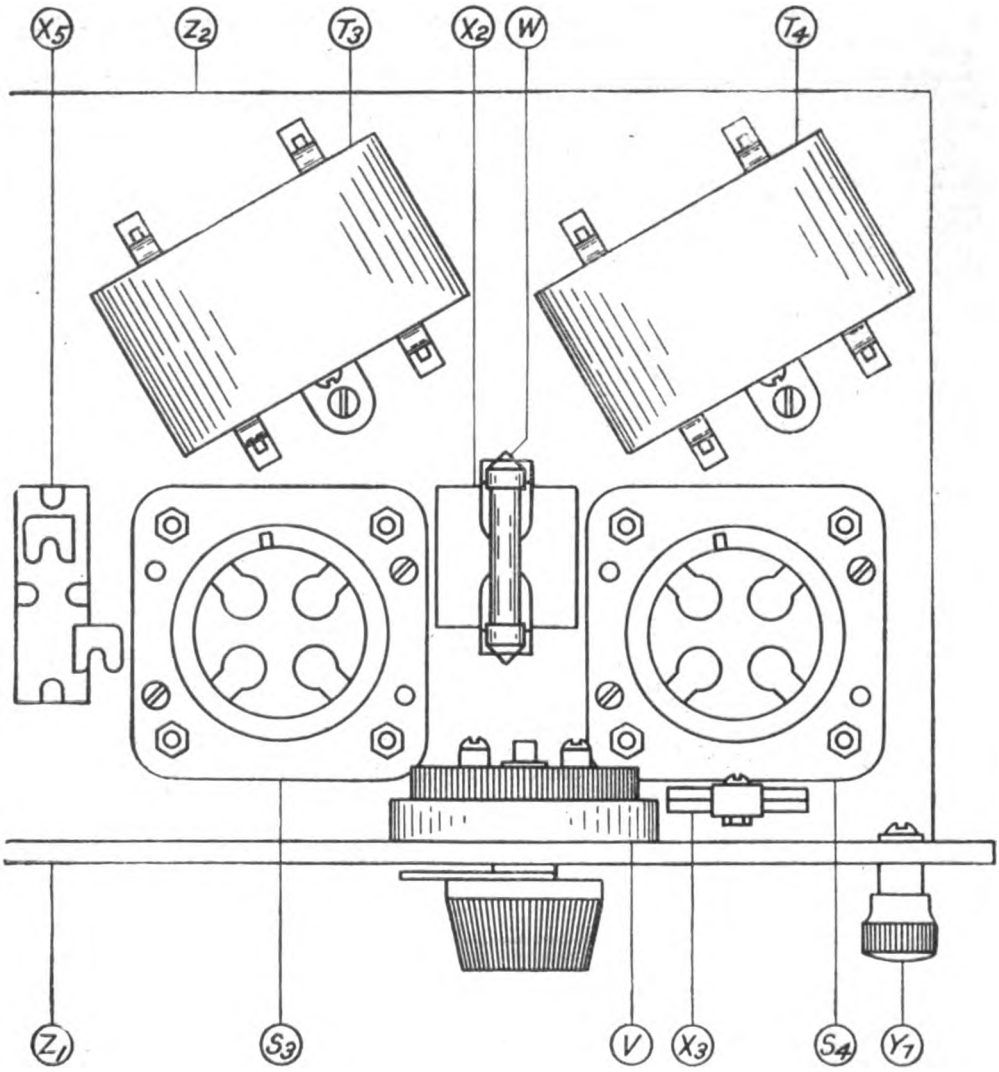

X4—Dubilier paper condenser, .5 mfd.;
X5—Dubilier paper condenser, .5 mfd.;
Y1 to Y12—binding posts;
Z1—composition panel;
Z2—wooden sub-panel, 6¼ x 14 x ½ inches.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel Z1, (shown in Figures 2, 3, 4 and 6).

First of all the panel should be cut to the correct size, 7 by 15 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 4.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next the sub-panel Z2, should be cut to the

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correct size, 6¼ by 14 inches, and painted with a dark *insulating* paint, and fastened to the main panel Z1, with wood screws running through the face of the main panel and into the edge of the sub-panel. (See Figures 4 and 6).

Now mount the potentiometer U on the main panel with two screws, and likewise the filament rheostat V, as shown in Figures 2 and 6.

Next, screw the four sockets S1, S2, S3, and S4 to the sub-panel Z2 by means of two brass screws to each socket. Secure the two paper condensers in a similar manner, X4 between the sockets S1 and S2 and X5 between the sockets S3 and S4. (See Figures 2, 3 and 6.)

Mount the input transformer T1, as shown in Figures 2 and 6, by a single brass wood-screw, and do the same thing similarly with the radio-frequency transformers T2, T3, and T4.

As the three condensers X1, X2 and X3 are supported by the wiring they may be left until the set is connected up. The condenser X2 should be of the type of micadon that has two clips for mounting the grid leak directly upon it.

Now mount and fasten, with screws on the rear of the panel, the twelve binding posts Y1 to Y12, in two vertical lines of six each, one line at one end of the panel and one line at the other. These binding posts should be fastened in the proper holes drilled for them in the main panel Z1.

A standard cabinet may be obtained for the amplifier; just ask for a 7 x 15-inch cabinet.

The dimensions for this cabinet are shown in Figure 5.

The construction work is now completed.

How to Wire the Amplifier

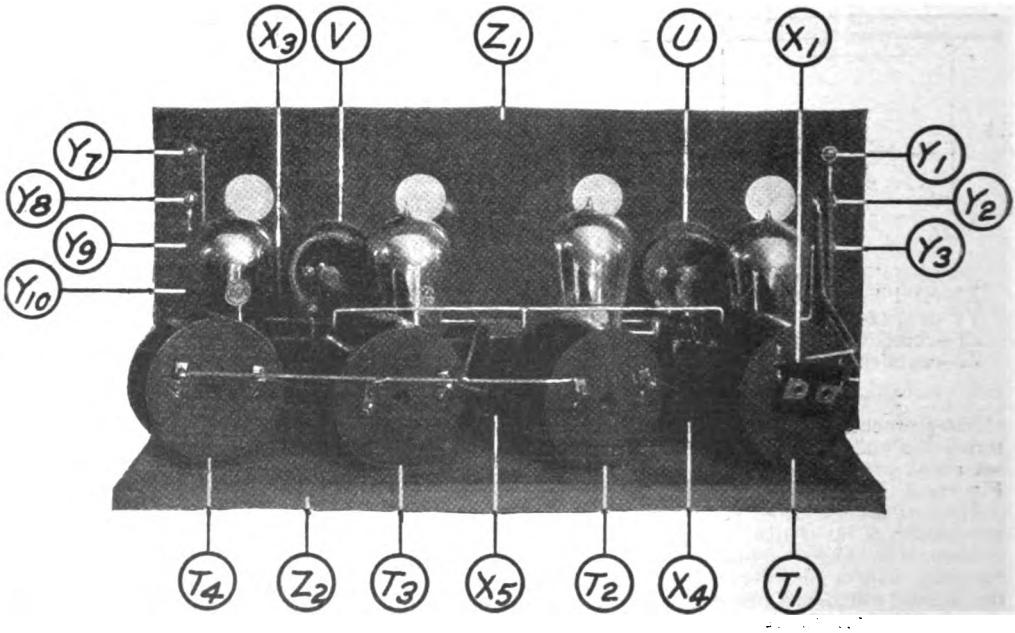
The amplifier should be connected up with bus wire in the following manner:

Connect one end of the primary coil of the transformer T1 with binding post Y1. (Posts Y1 to Y6 are located on the left-hand end of the panel, looking from the *front* and posts Y7 to Y12 are located at the right-hand end of the panel, also looking from the *front*. The wiring diagram in Figure 1 should be reversed if you figure out the connections from the *back* of the panel.)

The other end of the primary coil should be connected to post Y2 and the condenser X1 should be connected directly across the primary wires of the transformer.

Next connect three separate wires straight across from post Y3 to Y9, from Y5 to Y11 and from Y6 to Y12. Then connect posts Y4 and Y5 together and connect posts Y10 and Y11 together, with short bits of the bus wire.

The next job will be to connect potentiometer U across the two wires connecting Y5 to Y11 and Y6 to Y12. The mid-connection on the potentiometer should be connected to one side of the condenser X4 and one end of the secondary of T1, T2 and T3. The remaining end of T1 secondary winding should be connected to the grid terminal of the socket S1. Likewise with the remaining end of the secondary windings of T2 and T3; they should be



A VIEW OF THE AMPLIFIER FROM THE REAR

FIGURE 3: *Here is shown the general arrangement of the apparatus which is mounted partly on the main panel and partly on the sub-panel or base-board.*

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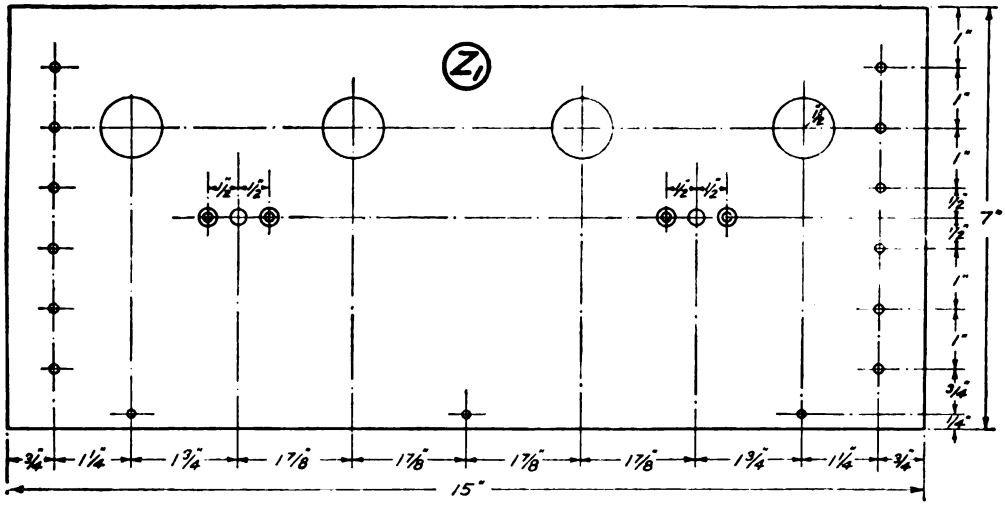

THE DIMENSIONS FOR THE MAIN PANEL

FIGURE 4: *By following this diagram, the correct size of the panel will be assured together with the correct spacing for the holes for the screws which hold the parts, and the shafts of the instruments which protrude through the face of the panel.*

connected to the grid terminals of sockets S2 and S3, respectively.

Now connect the remaining side of condenser X4 to the bottom wire attached to post Y6.

Then connect the condenser X5 across Y3 and Y6 binding posts, anywhere suitable along the two long wires connecting these two posts to posts Y9 and Y12, respectively.

Now connect condenser X3 across post Y7 and Y12.

Run a wire from Y12 to the pointer on the rheostat V. The other end of the rheostat should be connected to one of the filament terminals on each of the sockets S4, S3, S2 and S1. The remaining filament terminals on these four sockets should all be connected to the long wire connecting posts Y5 and Y11. From this same wire run another wire to one end of the secondary winding of the transformer T4. The other end of this winding should be connected direct to one side of the condenser X2 and the grid leak W. The other side of these two instruments should be connected to the grid terminal of the socket S4.

Connect the plate terminal of the socket S1 to one end of the primary winding of transformer T2. The other end of the primary T2 should be connected to the long wire connecting posts Y3 and Y9.

Do the same thing with the plate terminal of socket S2 and the primary winding of transformer T3.

Do the same thing with the plate terminal of socket S3 and the primary winding of transformer T4.

The last wiring job will be to connect the plate terminal of socket S4 to post Y7 and the hook-up will be complete.

Operating Data

To set up the various units after they have been completed and put in their cabinets is a simple matter.

First, place the Haynes tuning unit at the left-hand side of the table and next to it, on the right, place the oscillator. Then, at the right of the oscillator, place the amplifier unit that you have just completed. You may also place the two-stage audio-frequency amplifying unit at the right of the radio-frequency unit if a terrific signal is required—but this is not recommended by the author.

As all the cabinets are of the same size and finish they make a neat business-like appearance.

Now, just bridge across from one binding post on one unit to the binding post opposite it on the next unit as they stand together. This will give you six connections between the tuner unit and the oscillator unit, six between the oscillator unit and the radio-frequency amplifier unit, and so on.

Now, to connect the batteries and phones, do the following:

Connect the positive "A" battery to the post Y12 on the amplifier unit.

Connect the negative "A" battery to the post Y11 on the amplifier unit.

Connect the negative "B" battery to the post Y10 on the amplifier unit.

Connect the positive "B" battery to the post Y9 on the amplifier unit.

Connect one terminal of the telephones to the post Y8 on the amplifier unit.

Connect the remaining terminal of the telephones to post Y7.

Connect the antenna and ground to the two left-hand posts on the tuner.

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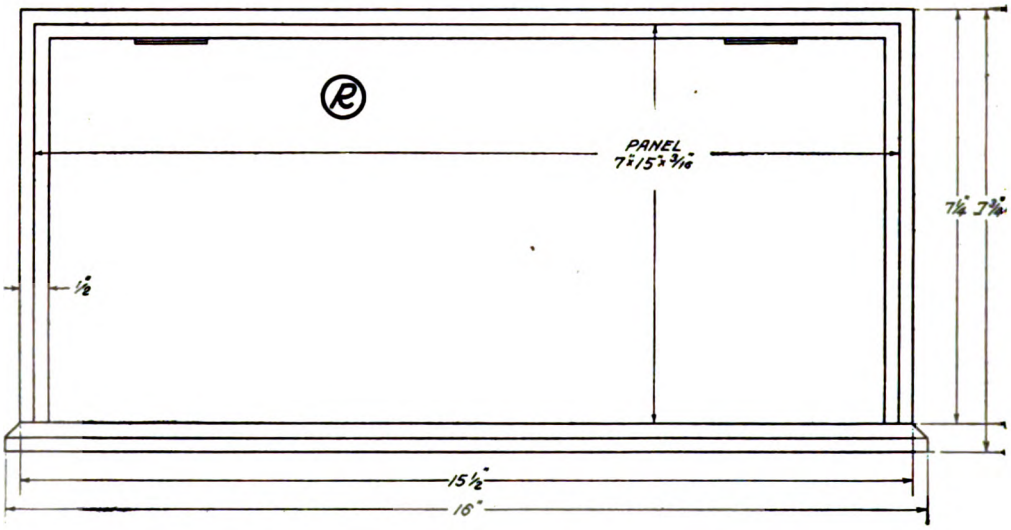

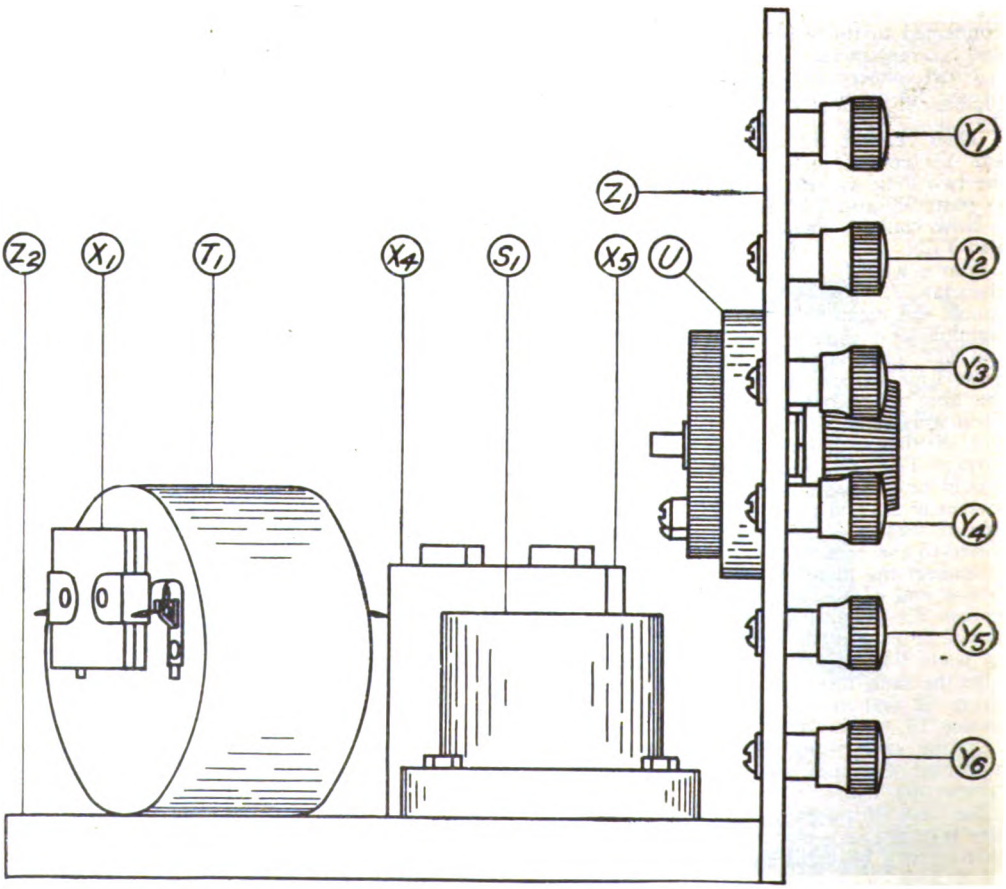

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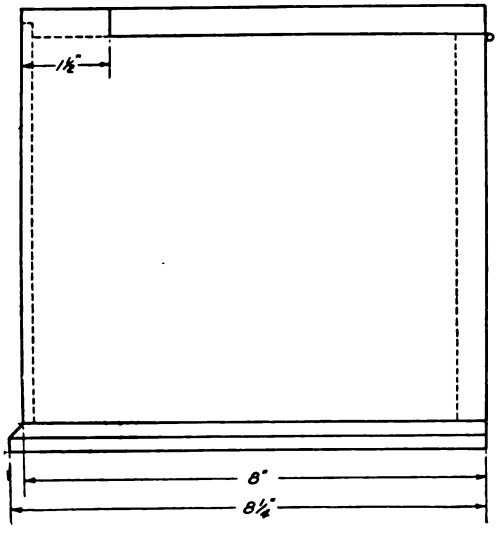

THE DIMENSIONS FOR THE CABINET

FIGURE 5: *This diagram (which contains the front and side measurements for the hardwood cabinet) may be turned over for construction to the cabinet maker or a cabinet of this size may be obtained from almost any radio supply store.*

All the other units will then be automatically connected to the batteries and to each other.

Next, place in the sockets six UV-201-a vacuum tubes, making sure before doing so that the rheostats in all the units are turned *off*.

Put the receivers on your head, but not too near your ears, and turn up the tubes to the correct brilliancy.

Then start with the initial adjustment. Place the regenerative control knob A1 on the tuner at a low value (say at 10). Place the oscillator-coupler knob K1 at a high value (near 100). Place the antenna switch F1 on the second tap from the left. Set the wavelength knob B1 at 40. Place the heterodyne control knob L1 at about 40. Then adjust the potentiometer knob on the amplifier, by turning in a clockwise motion until a loud rushing noise is heard in the telephones. Turn the potentiometer just a little further on beyond this point.

The initial adjustment is finished, now to tune in a station.

Turn the heterodyne adjusting knob L1 slowly in one direction or the other until you hear a signal. Then bring in the signal louder by adjusting with the wavelength knob A1. (These are the two knobs that you will use altogether for tuning; A1 to tune to wavelength and L1 to heterodyne the signals).

When you have these two adjustments made the best you can get them, start and go over all the other adjustments you have already made and thus get the set working, once and for all, at the highest efficiency.

When this is *once* done, you need not bother with the other adjustments again; they are only necessary to get the set working properly.

To get other stations, you may change the setting of A1 and find the corresponding setting for L1 to bring in this wavelength. You will find that for a given setting on A1 there will be a given setting on L1.

The regenerative control should only be used on extremely distant stations where it will be found a great help in making the signals audible.

When you have mastered the tuning method, you will find that you can tune in anything, no matter what the distance, if the wavelength is within the range of the tuner (180 to 550 meters) and if the static is not too strong.

You will find little interference and great sensitivity in such a set and the reception will be extraordinarily clear.

←AT LEFT: A VIEW OF THE AMPLIFIER FROM THE RIGHT-HAND SIDE

FIGURE 6: *This view gives a better idea of the grouping of the transformers, rheostats, condensers, sockets and binding posts, when considered from a "depth" standpoint. It should be noticed that the condenser X1 is mounted directly on the terminals of the input transformer T1.*

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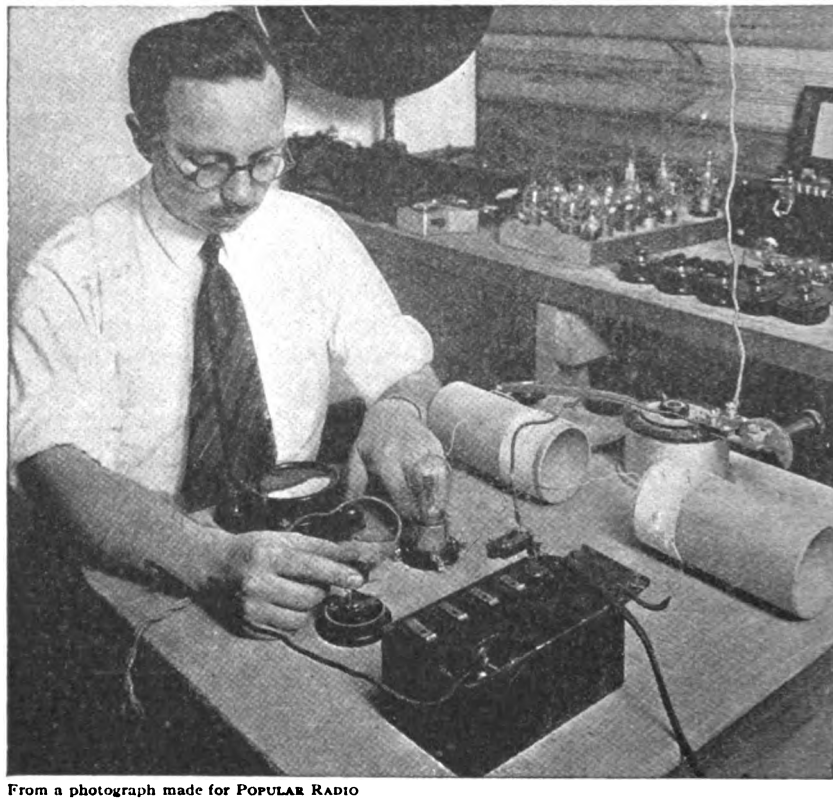

From a photograph made for POPULAR RADIO

"If you are now using an ordinary vacuum-tube detector, in a non-regenerative circuit, change to a good regenerative circuit and preferably one that is coupled inductively to the antenna."—JOHN V. L. HOGAN.

How to Increase the Selectivity
OF YOUR RECEIVER

Do you have trouble in tuning out interference now that the broadcasting stations are using the re-alloted wavelengths? This article by one of the best radio engineers in the world tells how to overcome your difficulty.

By JOHN V. L. HOGAN

SINCE the adoption of the new wave-frequency (or, in the old phrase, wavelength) allocations for broadcasting, the number of transmitters that can be heard by any receiving station has been substantially increased.

Under the former plan the transmitters were licensed to work at only two wave-frequencies — 833 and 750 kilocycles a second (corresponding to 360 and 400 meters wavelength). If the broadcasters had lived up to the regulations no one would have been able to receive from more than two stations, one on each wave, at any one time. As a matter of fact it was found that so much interference developed when only the two waves were used that the station managements gradually tuned their transmitters to

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waves a few kilocycles either side of the specified frequencies. This practice, together with the division of operating hours among the numerous senders that desired to transmit in each locality, helped out the situation a good deal. Despite the fact that it resulted in two groups of stations, the larger group operating in the neighborhood of 833 kc. and the other clustering about 750 kc. and even though the waves were chosen more or less at random, the shifting away from the authorized wave-frequencies made possible what little choice of broadcast programs was enjoyed by radio listeners last winter.

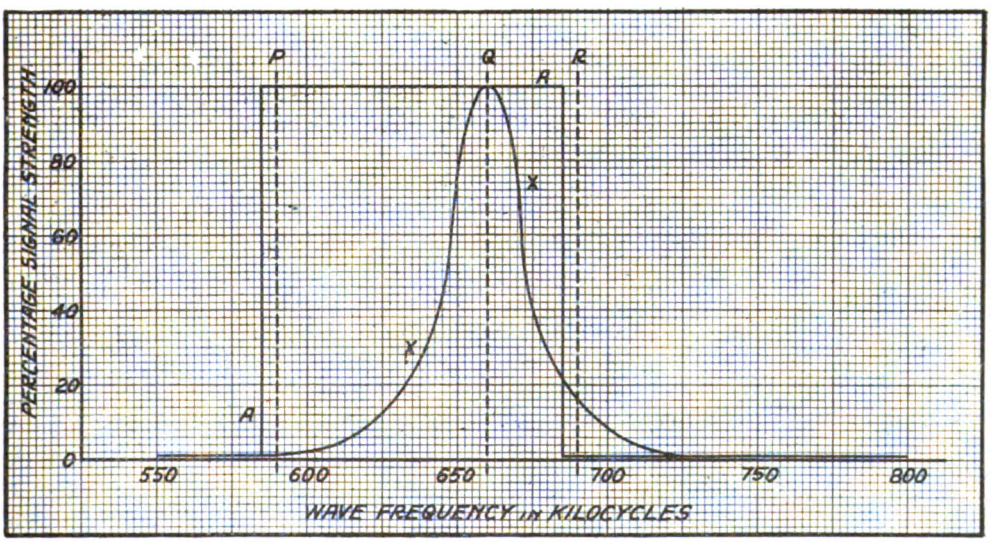
The Second National Radio Conference assembled by Secretary Hoover last March changed matters by devising a new schedule* of broadcasting wave-frequencies that assigned to stations in each locality an appropriate place in the wide band of waves that is now available for this public radio service. The Department of Commerce put the new plan into effect on May 15th last, and we have had ample time to learn that the new wave assignments mark a progressive step (and a large one) in broadcasting.

Some novice listeners have complained that the wave-frequencies of the various stations are too close together and that it is not possible to hear programs from one station without simultaneously picking up music or a speech from other broadcasting plants.

These complaints have come only from listeners whose receiving sets are poorly designed or poorly manipulated.

It has been proved that receivers of only average selectivity, adjusted with only normal care, are fully capable of discriminating between various broadcasting waves that are said to interfere with each other. If you are having trouble in picking out the station you want to hear, and in listening to that station alone, don't blame the new wave assignments. Bear in mind that thousands of other people are having no trouble at all, and get busy

*The new plan was reported in detail on pp. 64-70 of POPULAR RADIO for July, 1923.



A WAVELENGTH-SIGNAL-STRENGTH CHART

FIGURE 1: *The author's frequency-signal-strength chart which he uses to explain how a selective receiver and a broadly tuned receiver would act in regard to interference elimination.*

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on your receiver. Make it as highly selective as you can and enjoy the choice of programs that you will be able to get in that way.

Some of your neighbors (and probably a good many of them) have found that by sharp tuning they can hear any one of twenty or more stations at a time on "good nights" this season; last winter they were lucky to be able to choose more than five or six.

Let us look more closely into this matter of receiver selectivity.

The term is almost self-explanatory, it means the ability of a radio receiving outfit to select signals transmitted on one frequency of carrier wave from other signals that are simultaneously being sent out on waves of other frequencies.

Suppose we made a chart of some of the broadcasting wave-frequencies as in Figure 1, where the different values are arranged along a vertical scale. In this figure, the localities to which the various wave-frequencies have been assigned are indicated, as well as the corresponding wavelengths in meters.

Toward the right-hand side of Figure 1 is drawn a heavy vertical line, marked AA, with an opening equivalent in width to 100 kilocycles. Imagine that this line represents the barrier set up by your receiving tuner; that no wave energy can get through at the frequencies opposite the line, but that the wave-frequencies opposite the opening *can* get through to operate your telephones. From the diagram it is quite clear that a receiving set which admits a 100-kc. band (or continuous group) of wave-frequencies could simultaneously pick up signals from two of the New York stations, from Philadelphia, from Washington at 640 kc. and (if the signals were strong enough) from Pittsburgh, Chicago and a few others. This assumes that the particular set be located in the east; if it were on the west coast, it would simultaneously admit signals from San Francisco, Los Angeles and Portland.

Following the diagram's teachings a little farther we see that even a receiver so non-selective as this could choose between the three New York stations at 610, 660 and 740 kc. Although in the position shown it admits both 610 and 660 kc. by turning the tuner controls to give resonance to the lower frequencies (which would have the effect of lowering the opening in the line AA) the 660-kc. wave could be cut out. By raising the admitted frequencies 40 kc. above the illustrated values, 610 kc. would be cut out but 740 kc. not yet admitted. On the other hand, so broad a tuner could not be effectively used with a very sensitive detector and amplifier, for the increased responsiveness of the receiver would bring in interference from the more distant stations.

Here we have the crux of the whole tuning situation. Your receiving tuner *must be more and more selective* the *more sensitive your detector and amplifiers,* or the *farther you desire to receive.*

If you are in the vicinity of two or three broadcasting stations that use well separated wavelengths, and if you are satisfied to limit your reception to those stations, a relatively dull detector (such as a crystal) and a tuner with 100 kc. selectivity may be all you need. If, however, you want to reach out with amplifiers so as to hear Omaha, Detroit, Philadelphia or other stations whose wave-frequencies are not very different from each other, you will have to match your sensitive detecting system with a highly selective tuner.

You can see at once that the narrowness of the opening in the line AA (Figure 1) is a measure of the receiver's selectivity. If this opening is made more narrow, say to a width admitting only a 20-kc. range at one time, as in BB, the receiver sensitivity may be greatly increased without

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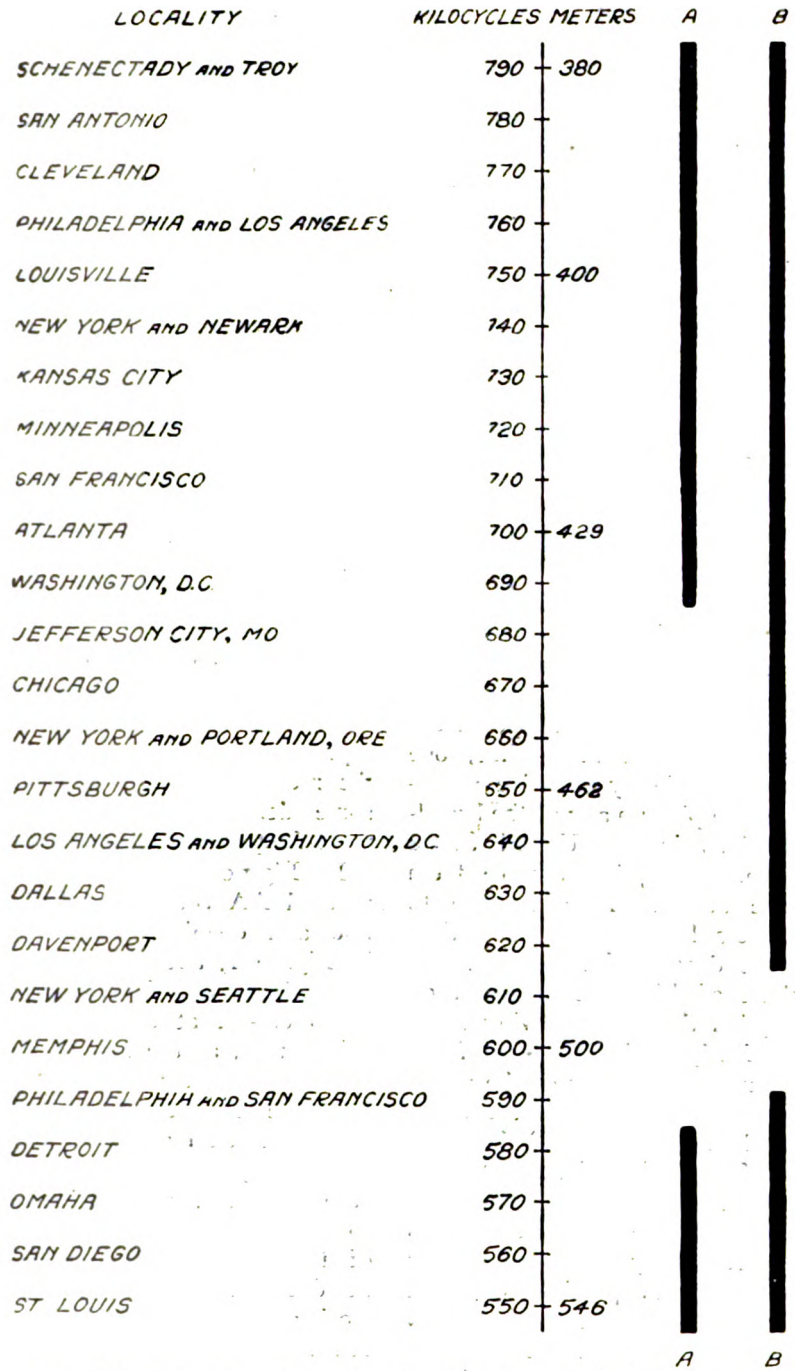

FIGURE 2: *This chart shows how a broad-tuning set would include the signals of a number of stations at one time while the sharp-tuning set would get only one or two. The small gap in the dark heavy line at the extreme right of the chart would include only New York, Memphis and Seattle. This line is for a sharp tuner. The large gap in the second heavy line includes everything from Jefferson City to Philadelphia and San Francisco; this line is for a broad tuner and considerable interference would be experienced.*

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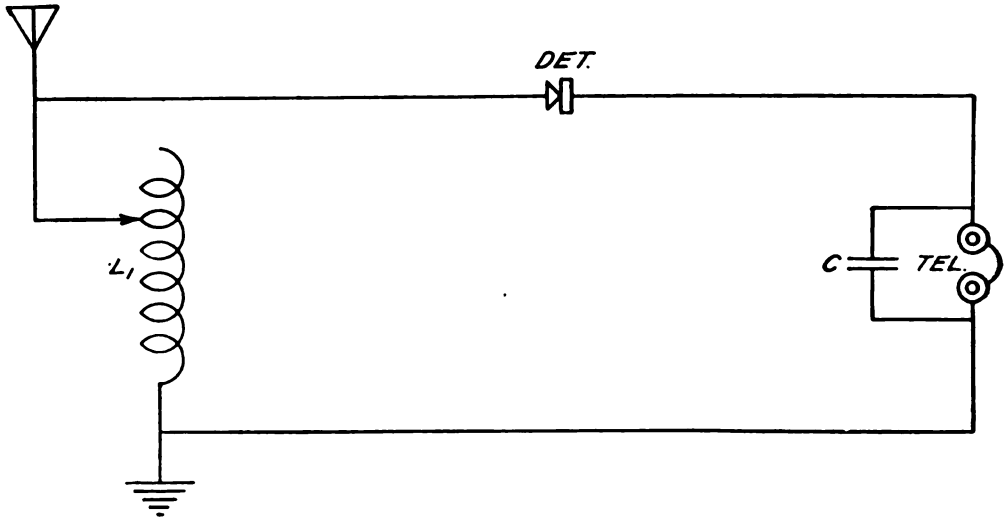

THE CONVENTIONAL SINGLE-CIRCUIT CRYSTAL RECEIVER

FIGURE 3: *Many beginners who have this type of simple set are experiencing trouble with interference. The author tells us that the trouble may be lessened if not eliminated by changing over this circuit to the circuit shown in Figure 5.*

bringing in interference, because the selectivity of the tuner has been much increased. With a tuner that would exclude all but 10 kc. at a time, one might use a sufficiently sensitive amplifying system to pick up any of the broadcasting stations in the United States without experiencing interference from any of the others. It is feasible to build receivers having even more than this extreme degree of selectivity.

The chart of Figure 1 is based on the assumption that the receiving tuner will admit freely, and with equal facility, energy received on any of the wave-frequencies that fall opposite the opening in the line AA (or BB) but that at the end frequencies of this admitted band the tuner will cut off sharply so as not to admit any energy from waves outside the frequency limits marked by the opening. It is possible to build receivers that have practically this sharp cut-off characteristic, but the ordinary tuners that depend upon simple circuit resonance for their selectivity have a gradual or tapered cut-off on each side of a single frequency that they receive best.

Figure 2 compares these two characteristics; here the frequency scale is drawn horizontally and the vertical scale represents the percentage response that the receiver would give to a signal of some definite intensity at all of the wave-frequencies illustrated.

In Figure 2 the square-shaped line marked AA corresponds to the barrier line and opening similarly designated in Figure 1, and represents a receiver that admits a 100-kc. wave-band with sharp cut-off at each end. It is easy to see that, at the setting illustrated, a wave of frequency 590 kc. (as used by some of the Philadelphia stations and indicated by the vertical dash line P) will produce 100-percent signals. A wave of frequency less than 585 would produce no response on account of the sharp lower cut-off. A wave of 660 kc. (used by WJZ in New York and shown at line Q) would give 100-percent response, but 690 kc. (Washington; line R) would be above the upper cut-off and give no signals.

Now look at the curve XX in Figure 2, which shows the selection characteristic of an ordinary but reasonably good

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receiver. When set to give a maximum response to 660 kc. (line Q, as shown) signals on carrier frequency 690 kc. (line R) would give only about 15 percent full response, while other signals of 590 kc. (line P) would produce practically no sound in the telephones.

We might make a table showing the percentage of normal or best signal strength that would be received by such a tuner for various differences of wave-frequency, using this resonance curve as a basis, like the following:

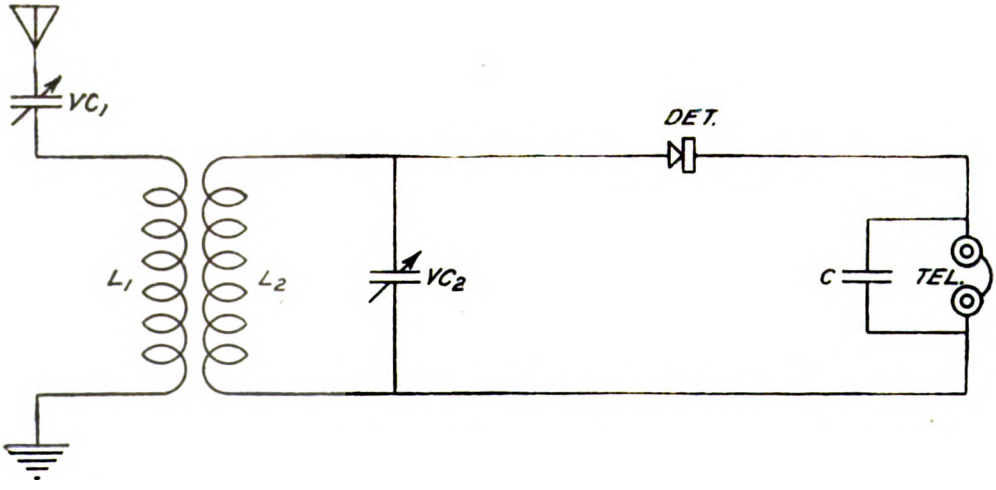
Difference from Resonant Frequency	*Percentage of Resonant Signal*
0	100
10	80
20	25
30	15
40	10
50	5
60	3
70	0

From such a table we can see just what to expect in the way of freedom from interference. For instance, if instead of tuning to 660 kc. as shown, you adjusted to New York (WEAF) at 610 kc., the energies of signals from other stations would be as follows (New York being rated 100 percent because tuned to its maximum):

Memphis and Davenport—80 percent of their maxima.
Dallas and Philadelphia—25 percent of their maxima.
Washington and Detroit—15 percent of their maxima.
Pittsburgh and Omaha—10 percent of their maxima.
New York (WJZ) and San Diego—5 percent of their maxima.
Chicago and St. Louis—3 percent of their maxima.
Jefferson City and others—0.

Note that these relative signal strengths are given as percentages of the loudest possible signal your set could receive from any particular station, and that each percentage refers to the signal from the station in question and that only. In other words, this above table will not show the relative signal strengths in comparison with the signal from some one station, such as the one to which the set is tuned. To get this information we must combine with the above figures another tabulation giving the *relative* signal strengths of the station in question. One or two examples will show how this can easily be learned, however.

Suppose that with your receiver, under some particular condition, you can hear New York (WEAF) with intensity 100, New York (WJZ) with



THE INDUCTIVELY COUPLED CRYSTAL CIRCUIT

FIGURE 4: *This is the best crystal circuit to use from a standpoint of selectivity It is even better than the hook-up shown in Figure 5.*

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intensity 60 and Philadelphia (WIP) with intensity 20. If your tuner has the selectivity characteristic of curve XX in Figure 2, can you expect to hear Philadelphia without even the faintest interfering signals from either New York station?

To find out the answer we need only note that Philadelphia's wave-frequency is 590 kc. and those of the New York stations 610 kc. for WEAF and 660 kc. for WJZ. The differences are 20 kc. and 70 kc.; if the receiver is tuned to WIP, the desired signals will be received at full 100-percent intensity or 20; WEAF's signals, being 70 kc. removed, would not be heard. But WJZ's signals, only 20 kc. away from WFI's would come in at 25 percent of their full strength of 60, or at 15 which is three-quarters as loud as WIP. Consequently WJZ would interfere with WIP under these conditions, and a more highly selective tuner would be required to receive signals from this particular Philadelphia station without interference.

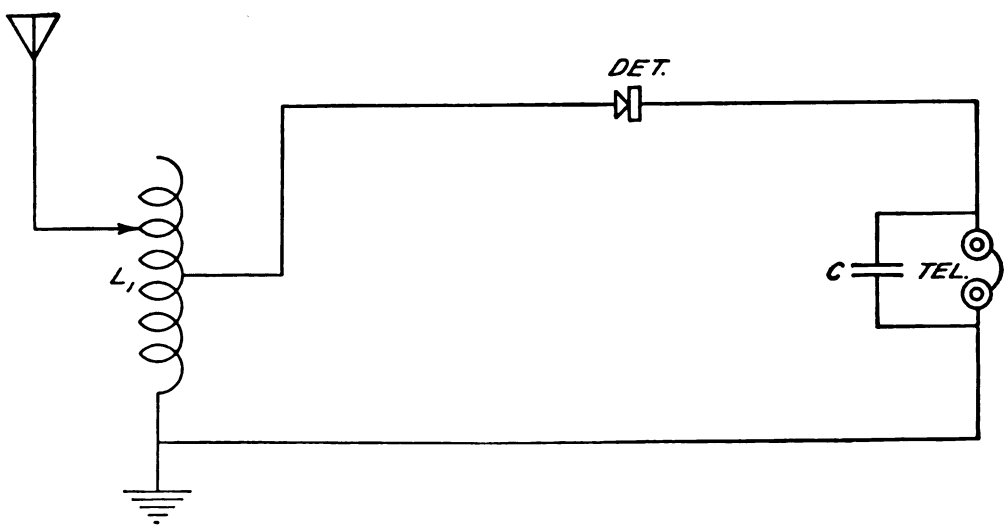
What can one do to increase selectivity so that such interference can be prevented? The details of all the answers to that question would be enough to fill the space of several articles such as this, but we can at least set down some of the high spots:

1. If you are using a crystal detector with single-circuit receiver (the ordinary form of which is shown in Figure 3), change over to the double-circuit receiver of Figure 4. If you cannot do this, at least tap the detector circuit across only a *part* of the inductance coil as in Figure 5.

2. If you are using an ordinary vacuum-tube detector, in a non-regenerative circuit, change to a good regenerative circuit and preferably one which is coupled inductively to the antenna (as in Figure 6).

3. If your interference conditions are too severe to be overcome by a circuit of the type represented by Figure 6 (a very unusual state of affairs), use a loop antenna with *tuned* radio-frequency amplifiers and regeneration, or, perhaps still better, with a super-heterodyne receiver.

Above all things, bear in mind that as much skill is required to operate a



A DOUBLE-CIRCUIT CONDUCTIVELY COUPLED CRYSTAL SET

FIGURE 5: *By using only a small part of the coil L1 for the secondary circuit which contains the detector and the telephones, the selectivity is increased to a considerable extent over that obtained by the circuit in Figure 3.*

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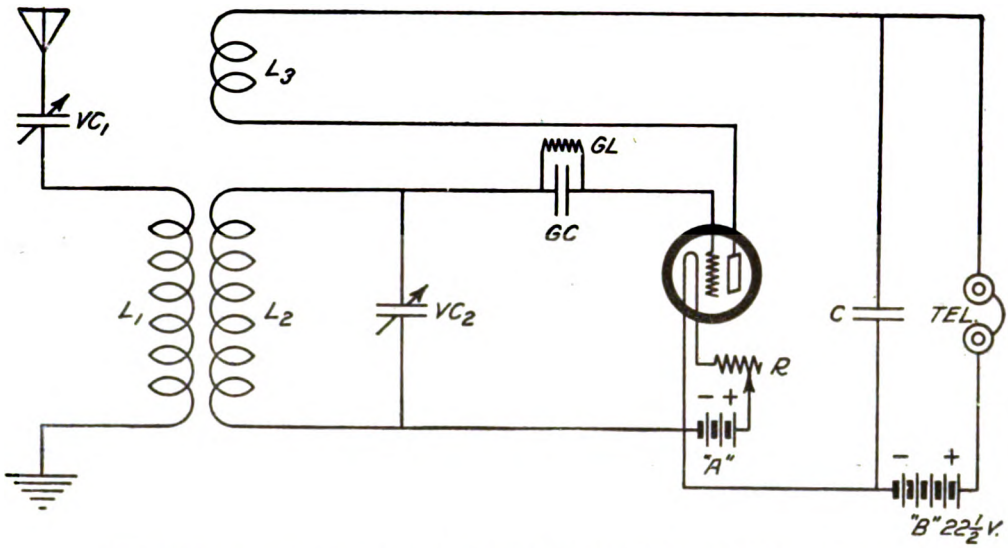


THE TRIPLE-CIRCUIT, VACUUM-TUBE, REGENERATIVE CIRCUIT

FIGURE 6: *By adding one more coil to your present single-circuit tuner you may greatly increase the selectivity and at the same time cut down re-radiation which is the most objectionable feature of the single-circuit hook-up.*

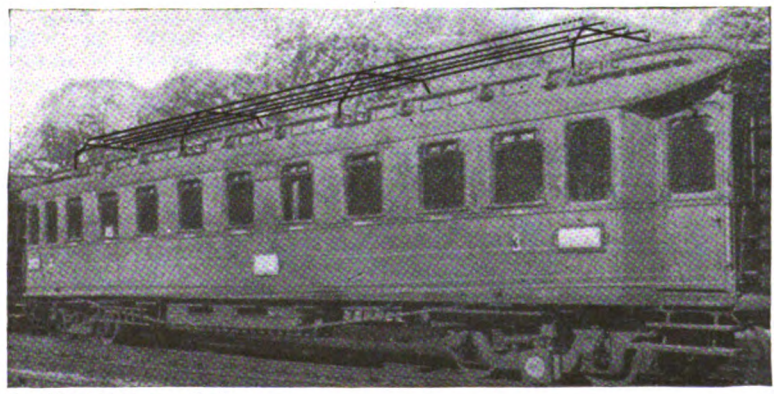
highly selective tuner as to drive a car through the heavy traffic encountered in a big city.

Don't expect to become expert in handling the tuner any sooner than the car. It is easy to pick up and enjoy programs from the local stations—as easy as it is to run a phonograph—but practice and patience are required to learn to hear all the available distant points through the local interference. But don't let that fact discourage you; you can do what others are doing, with a little perseverance, in really learning the facts about tuning.

If your object (or one of your objects) in radio receiving is to "get distance," get the most highly selective tuner and the most sensitive detecting and amplifying system that you can handle effectively, and work with it until you learn the tricks of manipulation. Your effort will be well repaid, and you will find that the new schedule of wavelengths makes these great results possible.

Radio Telephones on Trains

It is now possible to carry on conversation between trains in motion and distant radio stations. What recent experiments in this field have developed in this country, France and Germany will be told by Robert G. Skerrett in POPULAR RADIO for January.



Dr. Albert Neuberger, Berlin

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WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask the* SERVICE BUREAU

THE flood of inquiries that has poured in upon the Service Bureau has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

¶ *In justice to our regular subscribers, the Service Bureau is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry. No inquiries can be answered personally or by telephone.*

QUESTION: Please tell me which of the three modulation methods is the best: Heising, grid modulation or absorption modulation?

JULIUS MORRISON

ANSWER: The Heising scheme is the best in quality, and best in efficiency, though high in cost. It requires two tubes of equal power. The grid method is second in quality and efficiency, but is more economical in first cost. It requires but one tube. With two tubes it can *not* be as efficient as the Heising method.

The absorption method is efficient and the quality is good on extremely low power (say one 5-watt tube). But on higher powers the microphone heats up and introduces losses and distortion into the circuit. It is the most economical radio-telephone circuit for low power with one tube, for it needs no batteries for modulation—only a loop of wire and a suitable microphone.

* * *

QUESTION: Do I have to obtain a license for receiving in America? I had one when I lived in London and want to put up my set over here. If I need a license please let me know how to go about getting one.

KNOWLTON BAIRD

ANSWER: You do not need a license to own and operate a receiving set in the United States.

* * *

QUESTION: What is the speed of radio waves? Has this ever been ascertained?

EDWARD HORNE

ANSWER: Yes. The speed of these waves is 3,000,000,000 meters a second (in round figures). This is equivalent to about 186,000 miles a second.

* * *

QUESTION: What is a telephone repeater?

L. J. C.

ANSWER: A telephone repeater is one or a number of stages of audio-frequency amplification added to a telephone line to magnify or strengthen weakened voice currents that have traveled long distances across the country.

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QUESTION: Please send me a circuit for a small 5-watt CW transmitter. I am getting the transmitting bug; caught it from watching a fellow amateur who has helped me with my set when I had trouble.

Now I am able to fix my junk all by myself and feel that I would like to try to steal some of his stuff and surprise him with a set in full operation.

ADRIAN ROSCH

ANSWER: The wiring diagram for the transmitter is given in Figure 1. It is a simple Hartley oscillator.

The parts you will need are the following:
L—transmitting inductance;
GL—grid leak, 5,000 ohms;
GC—grid condenser, .002 mfd.;
key—well insulated transmitting key;
C—mica fixed condenser, .002 mfd.;
vacuum tube, UV-202 and socket;
power transformer, for lighting the filament and supplying the plate voltage.

You may make the transmitting inductance L yourself by winding 25 turns of No. 14 copper wire on a grooved composition tube, 3½ inches in diameter.

This circuit has been giving satisfaction at 7UD's station for over a year. He radiates 1.4 amperes and has worked 1,100 miles and was reported QSA (strong) at this distance.

The only adjustment to make with the set after the proper wavelength has been obtained is the grid-plate coupling which is adjusted by the sliding contact on the coil L.

QUESTION: Is it really necessary that antenna wires should be soldered? I have an indoor antenna, and I am afraid that if I try to solder the joints (there are three) I may damage the carpet.

I remember that when we lived in our other house I had an outdoor antenna which I soldered. In soldering it I also remember that the soldering paste melted down and fell on the roof. As the paste contains acid I know what it would do to the carpet. And if it did that to the carpet I know what would happen to my set. And I want to keep my radio set even if it does make me stay up late at night, and cause me to get scolded.

So again I ask, is there any way to do without soldering?

PERCY DICKINSON

ANSWER: Under the circumstances, you are safe! For an indoor antenna requires no soldering at the joints. You will find that the copper wire keeps reasonably clean and bright indoors.

However, in an outdoor antenna the copper wire will soon become oxidized or corroded and will make poor contact if not soldered. The soldering is only to make the joint a permanent affair so that its resistance will not increase with age.

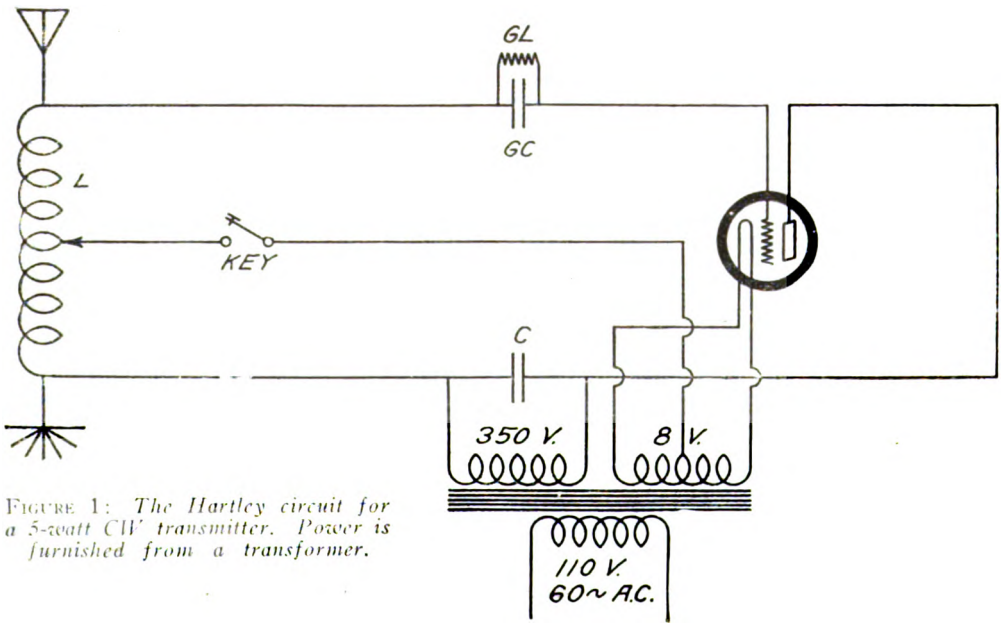

FIGURE 1: *The Hartley circuit for a 5-watt CW transmitter. Power is furnished from a transformer.*

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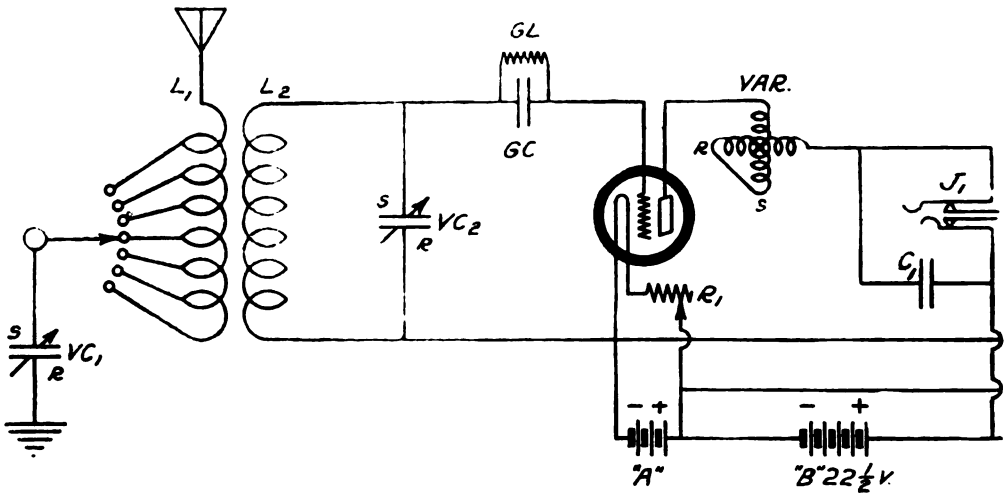

QUESTION: I have the following parts connected as shown in my sketch of the hook-up, which I am enclosing in my letter:

2 Malone-Lemon variable condensers, .0005 mfd.;
1 Cardwell variocoupler;
1 Mitchell variometer;
1 Dubilier combination grid leak and grid condenser;
1 rheostat;
1 UV-200 vacuum tube and socket.

Will you kindly give me a hook-up showing how to use this same circuit I am now using, with two stages of audio-frequency amplification added to it?

I have just bought one of the best loudspeakers to go with my set and when I tried it I did not get enough volume. I could just hear the music if I put my head right into the mouth of the loudspeaker. So I guess I must need an amplifier. Will you also tell me what extra parts I will need to go with my present apparatus.

D. J. WATTROUSE

ANSWER: In Figure 2 you will find the circuit you require. The extra parts you will need are:

C1—mica fixed condenser, .0005 mfd.;
J1 and J2—double-circuit jacks;
J3—single-circuit jack;
R2 and R3—filament rheostats, 20 ohms;
AFT1 and AFT2—audio-frequency amplifying transformers;
additional "B" batteries, 67½ volts.

If you use phones you will find that inserting the telephone plug in jack J2 will give you more distance than in your original set. The loudspeaker will give the best results if inserted in jack J3. You will need a separate plug for the phones and one for the loud speaker.

* * *

QUESTION: In using the new type of vacuum tubes, what side of the filament battery should the rheostats be connected in for an amplifying circuit? I have them in the positive side of the filament at present and the amplifier seems to work best when I use only 22½ volts on the plates of the amplifiers as well as the detector.

I have 90 volts of "B" batteries, and it seems a shame that I am unable to use only one 22½-volt section. The others will go to waste.

Someone told me I might have the rheostats connected in the wrong way and that I should follow the "dope" on the sheet which came with the tubes. I have not been able to find the sheet that I got with the tubes so I guess I am out of luck, as far as that is concerned.

I thought that you might perhaps help me out. Do I need "C" batteries?

WARD GIFFORD

ANSWER: For use as an amplifier the new UV-199 and UV-201a or C-299 or C-301a tubes should have the filament rheostat connected in the negative side of the "A" battery leads. You have them reversed and that is the reason

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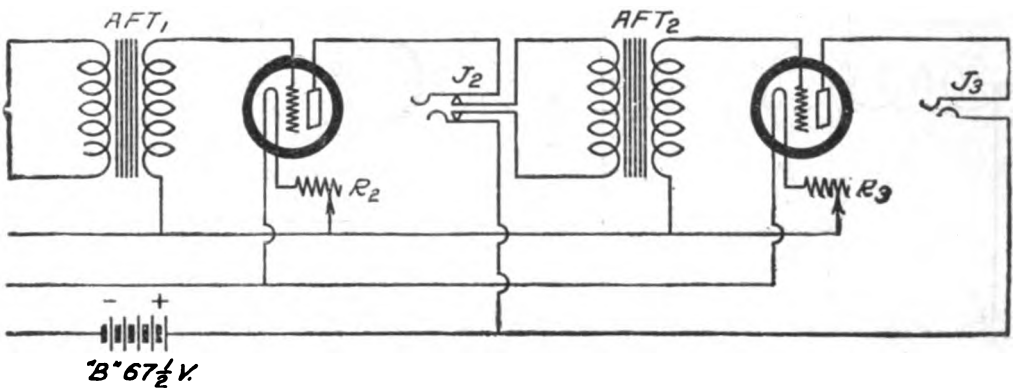
FIGURE 2: *A simple tuned-plate regenerative circuit that includes two stages of audio-frequency amplification. This circuit is easy to operate and tunes sharply*



that you cannot use more than 22½ volts on the plates of the tubes and still get good results. The grid return wire should also be connected to the negative end of the "A" battery for best results.

At the same time it would be a saving in "B" batteries for you to use a "C" battery included in the grid return wires from your amplifying transformers. These batteries should be connected in the circuit with their positive terminals connected toward the filament and their negative terminals connected toward the grid. For a "B" battery potential of 45 volts you need no "C" battery, the negative drop across the filaments will be enough. For a potential of 90 volts you should use a "C" battery of 4.5 volts and for a plate potential up to 135 volts you will require a "C" battery of 9 volts.

* * *

QUESTION: Sometimes while I am listening in for long distance, I hear a station which seems to be enveloped by a kind of wailing whistle. I listen to this station for awhile and the whistle seems to fade in and out.

The other night I heard this same kind of noise on WHN near by, and I kept on listening, and soon I could hear a sort of tattoo like someone beating a drum. I stuck to it to find out what it was and after about half an hour the tattoo noise developed quite strongly and finally I made out that it was an orchestra playing "jazz." A little later I heard the announcer during a quiet spell at WHN, announce that it was station WDAP at the Drake Hotel in Chicago. This is the greatest distance I have heard so far, and I am wondering if I was hearing it direct or through the power of station WHN?

Can you shed any light on this phenomena? I am curious to know if the one station was being carried by the other or just what was happening.

I have heard something about earth currents which flowed from the earth up into the atmosphere and have also been wondering if these earth currents may not be responsible for some of our distance records.

ROY SHELDON

ANSWER: When two stations are broadcasting on nearly the same wavelength, with vacuum-tube generators, they will produce a beat note that will be audible when tuned in with an ordinary receiver. The note you will hear will be the difference in frequency between the two transmitted waves.

If there were a difference in frequency of 500 cycles you would hear a whistle equal to about a tone of B-flat, two octaves above middle C on the piano. The strength of the note you would hear would depend upon the ratio of their signal strengths. Hence if either one were to die out or "fade," as it is more commonly known, the whistle would also die out and you would hear the other station which would then come in clearly. This is often experienced in DX reception. You may be listening to a far-off station and suddenly there will be a whistling noise heard in the receivers. A few minutes may elapse and you find the whistling sound diminishing until you are listening to a totally different DX station—and you haven't touched your tuning!

In your case you were picking up WDAP direct.

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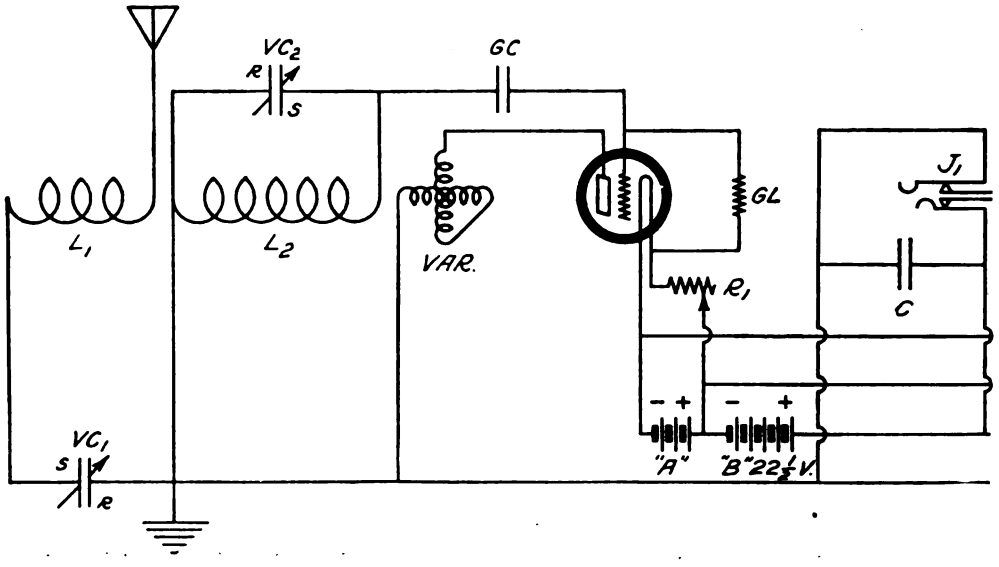

QUESTION: A number of the boys who live around here have been having such wonderful results with the DX receiver, described in your January issue, that I have at last decided that I would have to build one of them. However, when I sent for a copy of that issue I was told that it was all sold out. So I am writing you to request that you republish the wiring diagram with any useful information or improvements that you may have made. Also show me how to hook on the two stages of audio-frequency amplification so that I may use a loudspeaker.

E. MOORE SEVERANCE

ANSWER: In Figure 3 you will find the circuit for the DX regenerative receiver, otherwise known as the DX "bringer-in." In the improved set the coils L1 and L2 are wound on a composition tube 3½ inches in diameter. Coil L1, consists of 22 turns of No. 18 DSC. (double-silk-covered) wire and coil L2, consists of 50 turns of the same kind of wire wound ⅛-inch away from the coil L1. VAR is a variometer which is placed in inductive relation with coil L2. The distance between the edge of the stator winding of the variometer and the edge of the coil L2 winding should be ¾ of an inch.

The condenser VC1 is a .001 mfd. condenser with the rotor and stator plates connected as indicated by "S" and "R." Condenser VC2 is a .0005 mfd. vernier variable condenser.

The other parts are:

GC—mica fixed condenser, .00025 mfd.;
GL—grid leak, 2 megohms;
C—mica fixed condenser, .0005 mfd.;
R1, R2, and R3—filament rheostats, 6 ohms;
J1 and J2—double-circuit jacks;
J3—single-circuit jack;
AFT1 and AFT2—audio-frequency amplifying transformers (for first-stage, high ratio; second-stage, low ratio);
suitable "A" and "B" batteries.

Be sure that you use no shellac or any kind of insulating paint on the coil windings, and be sure that the windings are not shorted between turns.

In trying out the set for the first time, reverse the connections to the variometer, after a signal is tuned in, and leave it connected in the way it produces the *loudest* signals.

* * *

QUESTION: Why is it that I seldom hear any more player pianos from the larger broadcasting stations? I surely did enjoy some of their dance music. I think the piano was about the best sounding music that they ever sent out and now they have no more of it. Can you tell me why?

S. F.

ANSWER: This was prohibited for the larger broadcasting stations by the Secretary of Commerce; in fact only the stations operating on a wavelength of 360 meters or below were allowed to continue sending out player piano selections or phonograph music. The larger transmitting stations working on wavelengths above 360 meters must have real artists and no "canned" music is allowed.

You have probably been listening more to the larger stations than to the smaller ones, and this is why you have missed the type of music referred to.

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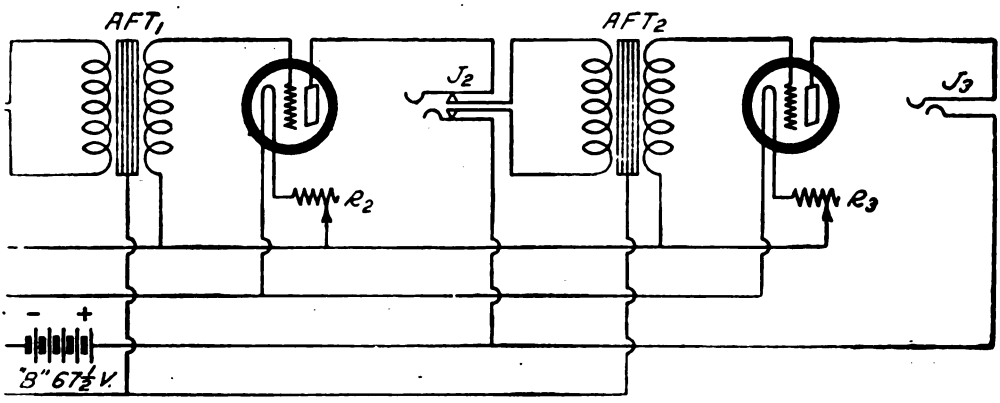
FIGURE 3: *The improved DX regenerative circuit as it has been revised to take care of the change in wavelengths of the broadcasting stations.*



QUESTION: What can I do to eliminate the squeaking in my set that occurs when the man upstairs tunes his set. I saw recently in POPULAR RADIO that this nuisance was caused by the single-circuit regenerative receiver, and until then I never knew what the squeaking was; I thought it was one of those peculiar things that go with radio. However, after reading the item in your magazine, I went up to visit him as a neighbor and verified your statements; he was using one of these sets and it *made the same kind of noise in his set* as I heard in mine.

I showed him the article in the magazine, and he was much surprised and really disappointed, for until that time he had thought his was a good set. He has asked me to write to you and find out how to tune it or what to do to help him eliminate the trouble. He is a good fellow, and really didn't know what an awful racket he was setting up until I brought him downstairs and let him listen to it for himself.

HAROLD H. BRECKENRIDGE

ANSWER: There are three ways in which the trouble could be eliminated. The surest way would be to get another set of the loosely coupled type, one employing two or more circuits.

Another way would be to add a single stage of radio-frequency amplification to the present set.

The third way would be to learn how to tune the set without ever allowing it to go into oscillation, and it is doubtful if this could be accomplished because while listening to distant stations the tube will oscillate extremely easily. This is because the regeneration is increased to such an extent in order to hear these stations, that the circuits are in a critical condition and will burst into oscillation at a slight change in wavelength of the tuning dials.

* * *

QUESTION: Why is it that my 5-watt transmitting tubes work all right for about a minute and then they seem to choke up? I was using them on a 350-volt DC. generator, but then I was using "voice"; now I am using ACCW. with 750 volts on the plate for telegraphy.

All of a sudden the antenna hot-wire meter drops to zero, the plates get white hot, and there is a blue fuzz in between the filament and the plate. I know I am using a higher voltage than the tubes are supposed to operate with, but I am wondering if you cannot tell me how I might use it and still keep the tubes from overheating.

SAMUEL BROWN

ANSWER: Although you are using the tubes at an overrated voltage you can keep them at the correct temperature by slightly changing the plate and grid adjustments of the set so that the plate current is reduced. It is evident that your set is only slightly overloaded because the tubes *do* stand up for a time. If you cut down the plate current (say about 25 milliamperes) you will undoubtedly prevent the tubes from slowly developing too high a plate temperature which finally ionizes the tubes.

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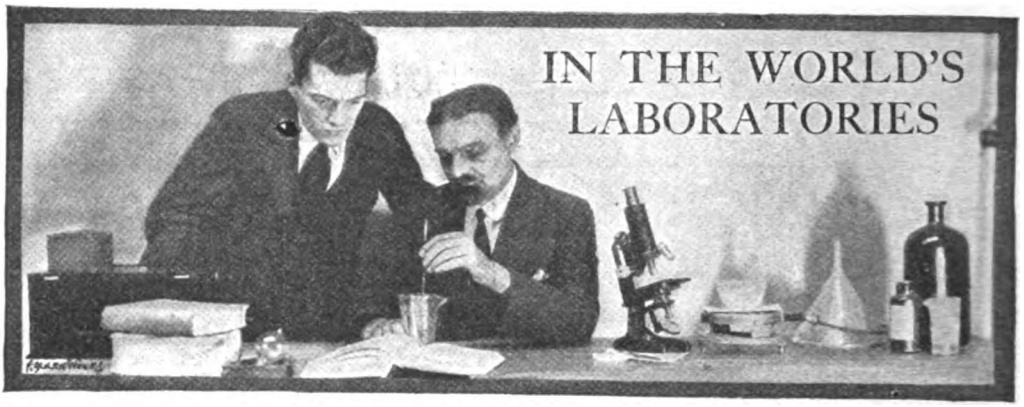

Will We Run Our Automobiles with Power Obtained by Radio?

THE newest suggestion of how to meet the prospective shortage of automobile fuel comes from France. It is that we might equip our roads with high-frequency power cables and run our autos by radio.

The process is suggested by Maurice Leblanc as a development of his plan for supplying radio power to railway trains. According to *La Science et la Vie* (Paris), the suggested system for railways consists of a pair of conductors suspended above the right of way and supplied with current at a frequency of 20,000 cycles a second. On top of the locomotives (or coaches) are two similar conductors, mounted so that they are parallel to the line conductors and at a distance from them, when the train is on the rails, of about sixteen inches.

These conductors on the train pick up the high-frequency waves from the fixed conductors by electromagnetic induction, just as a receiving station picks up radio waves sent out from a transmitting station. The high-frequency impulses thus produced are converted, on the train, into three-phase current at 15 to 25 cycles and this is used to drive the motors in the usual fashion. The conversion is made in the standard manner by means of vacuum-tube rectifiers and a rotating commutator.

The application of this system to the propulsion of automobiles is obvious. Cables carrying the high-frequency current would be suspended along the main roads and cars would be provided with reception conductors, converting equipment and three-phase motors, just as are the trains. There would be an obvious disadvantage in that the automobile could not operate at any great distance from the driving cable and would be confined, therefore, to the roads that were so equipped. But this might be avoided by supplementary storage batteries on the car.

It would seem that the most obvious opening for a system of this kind would be on motor-bus lines operated by what are now known as trackless trolleys. It is to be hoped that an actual trial of this kind will be made.

As an incidental to his system of train propulsion Mr. Leblanc has designed a high-frequency generator consisting of a vacuum tube operated by the vapor of mercury and provided with a fourth electrode for the purpose of maintaining the mercury arc. Several novel features of design are indicated by the sketch on page 519.

Does Static Come from Outside the Earth?

THIS is an implication that cannot help suggesting itself when one examines the results of static studies by Dr. Max Bäumler, reported in a recent number of the *Jahrbuch für drahtlosen*

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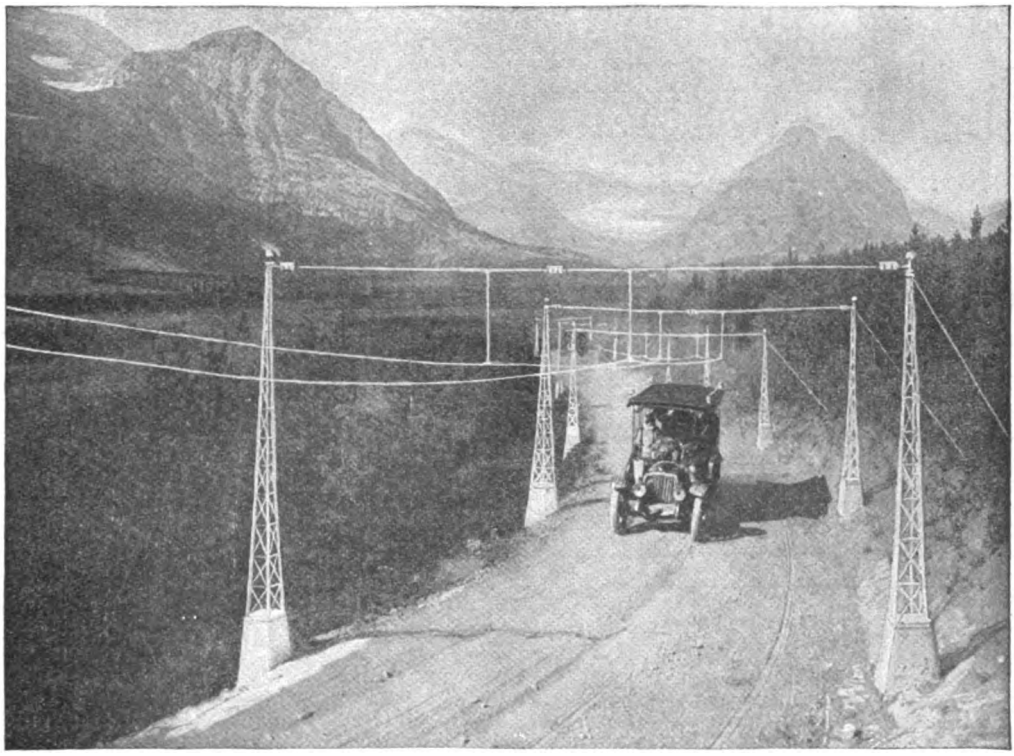
Telegraphie und Telephonie. By means of automatic recording apparatus Dr. Bäumler has compared carefully the records of single static disturbances received at four widely separated stations, three of them in Germany and the fourth the station of the Radio Corporation at Riverhead, Long Island. He finds, surprisingly, that a large proportion of the static disturbances, the individual clicks or roars, are simultaneous and of about the same strength, not only at the German stations but at the distant Long Island station as well.

If static is due, as is frequently supposed, to local thunderstorms it is difficult to imagine how the waves originating on one continent can reach another continent with their strength so little impaired. Dr. Bäumler does not discuss this problem. He would object, no doubt, to deducing from his results any conclusions not directly warranted by his data. But those of us who are inclined at all to speculation cannot help wondering whether these new facts about static may not mean that some, at least, of the disturbances originate in the Heaviside Layer or even above it, this layer functioning as a sort of great transmitting network high above the earth and from which the disturbing impulse is sent downward to the ground from all parts of the layer at almost the same instant all over the earth.

It has been suggested, for example, that static is due to meteors. This seems improbable in the light of the opinion of astronomers that the average meteor is a tiny particle even smaller, probably, than a grain of wheat. But there is another sort of cosmic visitors



WILL OUR MOTOR CARS RUN BY RADIO POWER?

If we equip our roads with high-frequency conductors radio power can be supplied to automobiles, says Mr. Leblanc, especially in mountain country where water power is usually cheap and where gasoline is dear.

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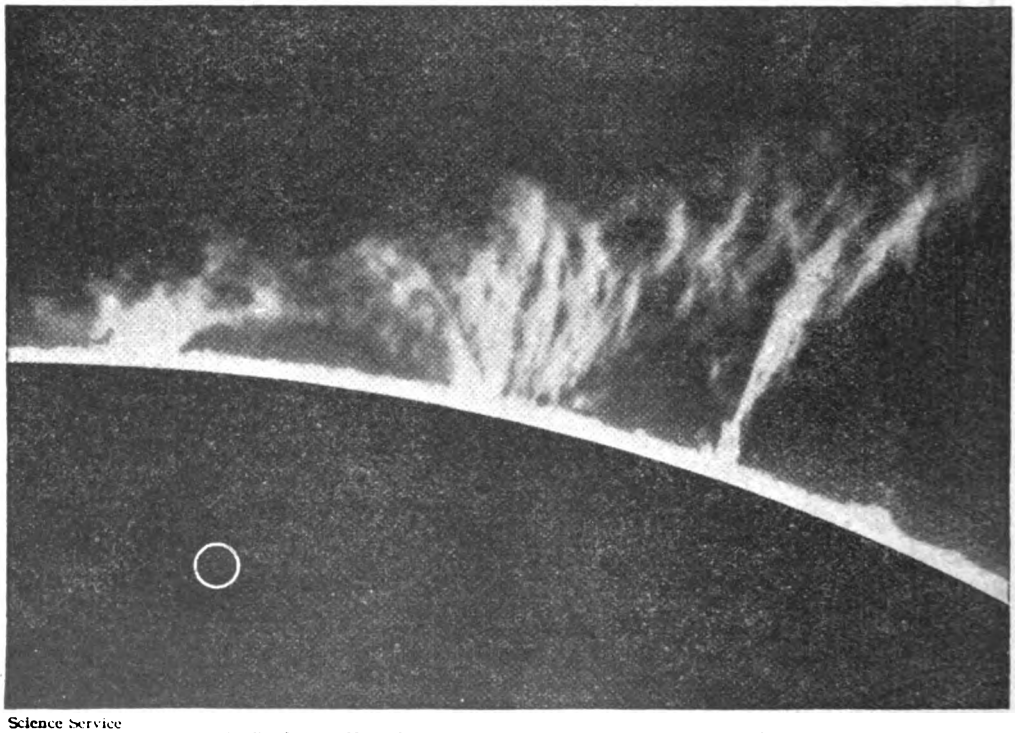
that may be more important. These are the clouds of charged gas or tiny dust particles that are supposed to be shot out frequently from the sun, especially from the great centers of solar disturbance that we know as sun-spots. One of these clouds hitting the Heaviside Layer would give it, probably, a sudden increase of charge. This might start a wave downward from the layer just as a sudden charge added to an antenna will start a sharp single wave outward from it.

Each click that you hear when static is bad *may* be the signal that another solar messenger has knocked at the outside door of the earth.

Are There Unsuspected Sources of Power?

THE problem of what the world is going to do for power when all the coal and oil have been used up is one that has agitated economists and scientific men for a number of years. It has been raised again by Dr. E. E. Slosson, distinguished American chemist and now Director of Science Service. We have enough coal, of course, for this year and for quite a few years in the future, but ultimate exhaustion of it is inevitable, and each increased use of power brings that fatal day a little nearer.

The confidence so often expressed that science will find some way for us to escape this threat of a power-less world is, Dr. Slosson says, "flattering—but unfounded." Many sources of power are known, but we do not know, in most cases, how to get the power out usefully. The scientific and engineering professions should make an immediate effort, Dr. Slosson urges, to



Science Service

A SOLAR FIRE-FOUNTAIN 80,000 MILES HIGH

This remarkable photograph made at Mount Wilson Observatory shows one of the great solar storms that shoot out clouds of charged particles toward the earth These particles may be one cause of static. The white circle is the size of the earth on the same scale.

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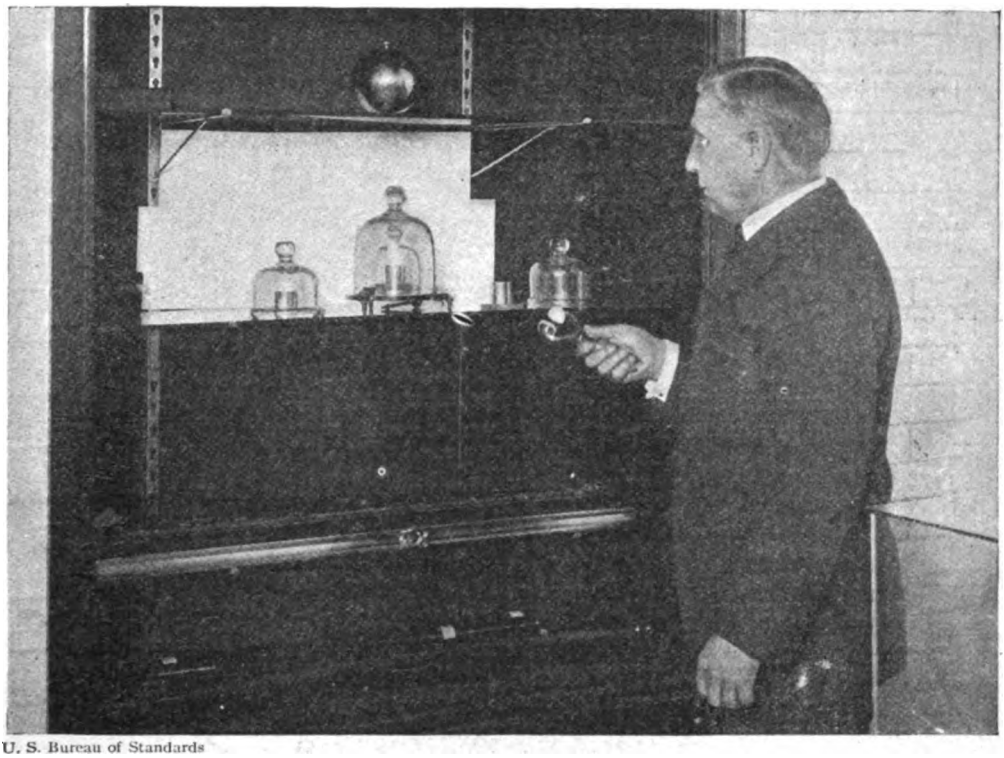

U. S. Bureau of Standards

THE STANDARD KILOGRAM AND METER BAR

The fundamental standards of weight and measure for the United States are the standard kilogram, under the glass case in the center, and the standard meter bar on the shelf just below. All units, even the electric ones like the volt or the watt, depend on these two fundamental units and on a third, the second of time.

inventory all possible or probable sources of power so that intensive study of the more promising ones can be begun.

All our present power, with negligible exceptions, comes from the sun. Coal and oil are derived from ancient sunlight by which the plants that produced these fuels grew in former geologic ages. Water power is really the power of the sun, translated into water raised from the sea and fallen as rain on the land. Winds, wood used for fuel, alcohol produced from vegetation; all are manifestations of this same solar power.

Much of the solar power that falls on the earth's surface is not used. Perhaps engines can be devised to catch and use this. Then there are a few known power sources that are not related to the sun. The tides constitute one of them, these being due to the attraction of the moon and drawing their energy, really, from the rotation of the earth. Another source to which Dr. Slosson refers is the internal heat of the earth, now being used in a very small way by steam plants located near volcanoes and hot springs. Still another is the power known to be held inside the atoms of matter but which cannot be got out except in the quite special instance of radium and the analogous elements.

All these power sources, Dr. Slosson insists, must be studied and evaluated if the world is to escape ultimate disaster. Still other sources must be thought of and studied too.

Radio engineers ought to join this procession. Are there any unsuspected radio sources of power? How about,

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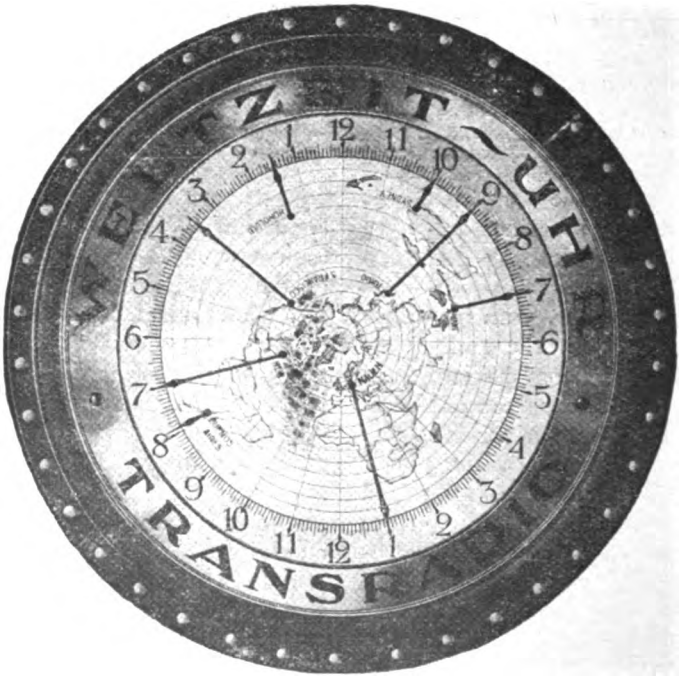
for example, radio impulses which may be received from time to time from the sun or other heavenly bodies? These have been little studied. It may seem a long step to the idea that power might be got in this way, but stranger things have already happened in the brief history of radio.

Better Crystals for Detectors

IT IS probable, suggests a writer in the *Mining Journal* (London), that the resources of mineralogy have still much to offer to the radio engineer. Out of some thousands of minerals which the mineralogists have identified only a very few appear to have been tested as crystal detectors. Most of the crystals commonly used are metallic sulphides like pyrite, which is a sulphide of iron, or galena which is a sulphide of lead.

But there exist, says this writer, many other minerals that ought to be even more valuable. Examples are pitchblende and the similar radioactive minerals. The conductivity of these minerals is good and they have the further property (because of their radioactivity) that they emit electrons spontaneously. Other "prospects" are tantalite and columbite which contain the rare metals tantalum and columbium, monazite which contains thorium and other unusual elements, samarskite which contains uranium, and others.

It would probably be worth while for some radio enthusiast who has access to a good mineral collection to make systematic tests of all the known metallic minerals, not forgetting that different fragments of the same mineral often vary greatly in detecting power and that, accordingly, a number of pieces of each one should be tested, both alone and with a biasing potential such as has to be used with carborundum



A UNIQUE CLOCK FOR RADIO OPERATORS

This timepiece, which was designed in Germany, shows the time in all parts of the world simultaneously. When the radio amateurs begin to listen regularly to European broadcasting, clocks like these will be useful to check up the schedules of the foreign stations.

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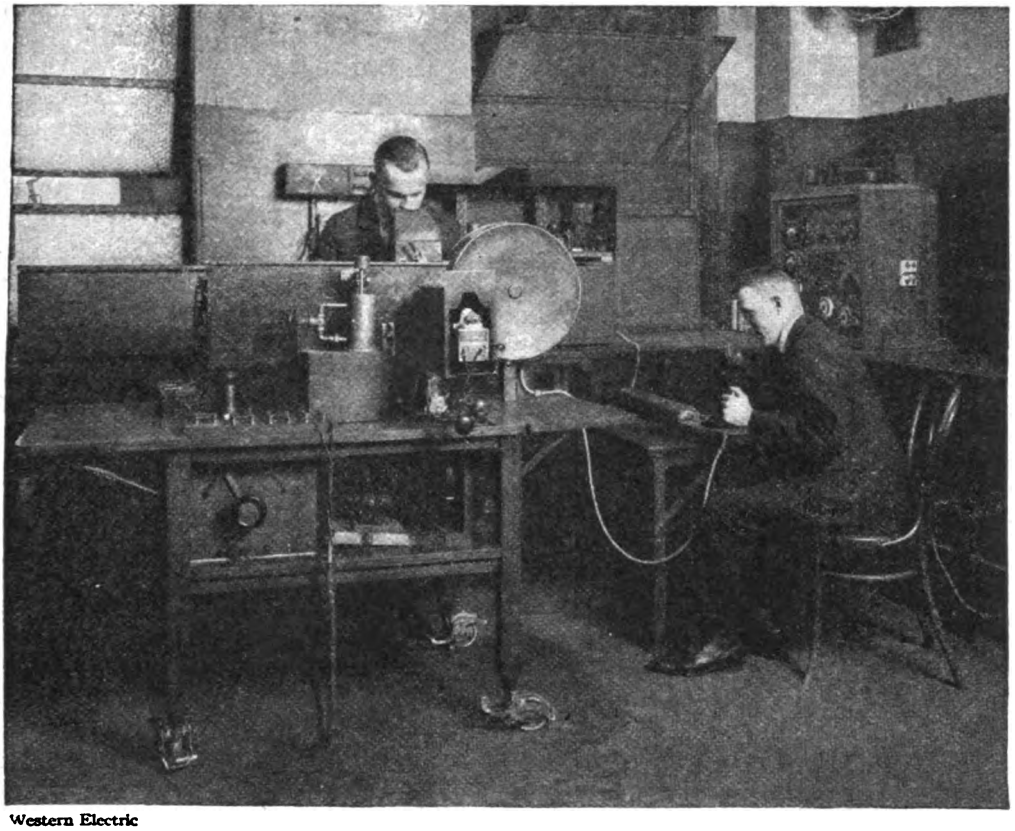

Western Electric

AN INSTRUMENT USED FOR DESIGNING LOUDSPEAKERS

This special oscillograph was devised for the study of the vibration frequencies in speech sounds. The voice of the operator at the telephone is magnified and made visible on a screen so that the other operator may see exactly what frequencies and wave forms are associated with each vowel and consonant sound and what happens to each frequency when it passes through electric or magnetic apparatus.

The Earth as an Electric Generator

THE surface of the earth in northern latitudes is usually charged negatively with respect to the atmosphere. There is accordingly a small electric current flowing all the time through the air, or rather between the air and the soil. It is small on any square foot, but for the whole earth it may equal, scientists calculate, as much as 2,000,000 amperes —enough to keep about four million electric lamps burning all the time. The electric and magnetic properties of the earth, of which this surface current is one, are probably of great importance in radio communication.

Why It Is Difficult to Produce a Really Good Loudspeaker

THE search for a better loudspeaker continues to absorb the attention of radio engineers all over the world. Yet it is safe to predict that not one of these will prove to be fully satisfactory. The perfect loudspeaker remains to be invented.

The extraordinary difficulty of this effort is not hard to understand when one sets down the number of different scientific problems which demand solution before this invention is possible. A cursory look through recent loudspeaker literature discloses at least six or eight of these problems.

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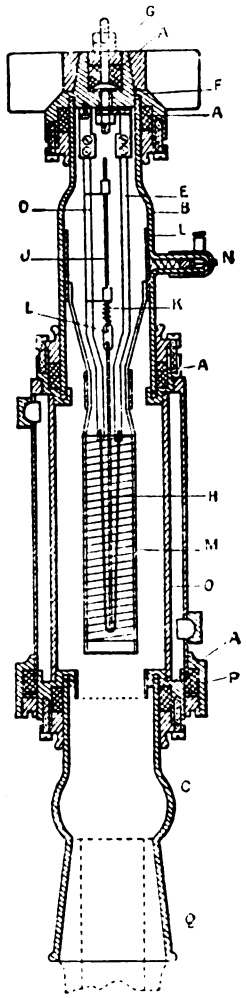
The most important and well known one is that of electric distortion in the circuits. This is really a name for the habit of any electric speech-transmitting apparatus to absorb and remove from the sound some of the frequencies that ought to be in it. The human voice, for example, sounds sharp and nasal when it loses its lower frequencies (say below 1,500 cycles a second) and hoarse and throaty when it lacks the normal higher frequencies. All of the frequencies from about 200 cycles to 4,000 or over must be present and must come satisfactorily through the apparatus if the reproduction is to be reasonably normal.



THE NEW DEMOUNTABLE VACUUM TUBE

The parts B and C are of glass, joined to the other parts of the tube by the four rubber gaskets indicated by A. M is the grid of molybdenum wire, the electric connection for it being at N. The plate is the copper cylinder O, cooled by the circulation of water in the space outside it. The vacuum is produced and maintained by a pump attached inside the cone Q by means of a ground-glass joint.

Then in addition to the electric distortion (determined, of course, by the combined capacities, inductances and resistances of the circuits) there is a magnetic distortion due to the fact that the magnetic properties of iron are not perfect, that any electromagnetic system which one can devise will always respond more readily to some frequencies than it does to others.

And when one has solved these two troubles there are the peculiarities of the diaphragm to reckon with; its persistent tendency to seize hold of one particular frequency that it happens to like and sing it out at one to the practical exclusion of all the other tones that ought to come out too. The horn or other sound-magnifying device adds still other peculiarities. Like the diaphragm it has its preferences, and it insists that the listener shall hear them.

Then a loudspeaker must be heard, usually, in a room, and the room, too, has its acoustic properties and preferences. There are echoes and rattles and the absorption of sound by hangings, all to be reckoned with. A person speaking in a room or anywhere else adjusts unthinkingly the loudness and quality of his voice to the needs of the circumstances; such as the size of the room and the number of auditors. No one has yet invented a brain for the loudspeaker that will enable it to do this.

Finally there are a couple of difficulties that are in the auditor instead of in the apparatus. The human ear is one of them. Gallileo is reported to have said that if any optician had sent him an instrument so imperfect as the human eye he would have returned it

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in disgust. If he proposed to get as mad as this about an eye, which is, after all, a fairly effective light detector, what *would* Gallileo have done about an ear? No two human ears are alike in the tones they hear nor in how they hear them. A person's hearing varies, even with the time of day or with what he had for dinner!

This is one of the imperfections of the auditor that the loudspeaker inventor has to take into account. He must realize that his instrument will have to be so clear in tone, so perfect in reproduction, that *anyone* can understand it, even people who have really only about half an ear to hear with.

The other personal imperfection of hearers is psychological. It is due to inattention. Many people get interested in something else and miss whole sentences of a lecture or a stage performance. They do not seem to mind this but let the same thing happen for the same reason with a radio apparatus and soon letters will be written to the manufacturer. These psychological and physiological peculiarities of us humans have not had from the radio designer as much attention as they deserve.

Note how many problems in what we used to call "pure science" are opened up by this one device of the loudspeaker. One is the problem of what is magnetism, for if we knew all about the magnetic behavior of iron we could avoid, probably, the various varieties of magnetic distortion. Others are the problems of the interference and resonance of sound waves in material bodies like horns, problems that were investigated so brilliantly by the late Professor Sabine of Harvard. Still another is the problem of cohesion and of what controls elasticity, for this it is that determines the vibratory properties of diaphragms. And then there are the problems of human physiology and psychology, those that concern the mechanism of hearing both in the ear and in the brain.

A Vacuum Tube That Comes Apart for Repairs

THE accidental circumstance that the vacuum tube was developed out of the electric lamp has given to the form of this useful instrument some characteristics that are from the engineering viewpoint, a serious handicap. The glass bulb is one of them. When the filament burns out or the grid connections come loose the glass bulb must be destroyed and remade (or resealed), which makes the repairing nearly as costly as a new tube.

So long as tubes were of small power and used only for reception this was not, perhaps, a matter of much importance. But as tubes advance more and more into the class of engineering equipment this impossibility of easy repairs must be escaped in some fashion. Imagine an electric motor that had to be thrown away whenever the armature burned out!

Hence the demand, growing more and more insistent, for a demountable and easily repairable form of tube. The development of such a tube is, we believe, inevitable. Indeed one form that has been constructed and is on trial in the Eiffel Tower station at Paris is illustrated in the diagram on page 524, which we take from *La Nature* (Paris). The tube is completely demountable; all joints are held gas-tight by gaskets of special rubber free of volatile matters and of excess sulphur. The rating is 10 kilowatts, the antenna input, at a plate potential of 5,000 volts, being about 8 kilowatts. The necessary vacuum is maintained by a pump of special design to which the tube is attached.

It is natural that the development of a demountable tube should begin with high-power units of this kind but it may be expected to extend to smaller tubes as well. Even the tubes used for everyday reception will probably take on before long new designs leading in this same direction.

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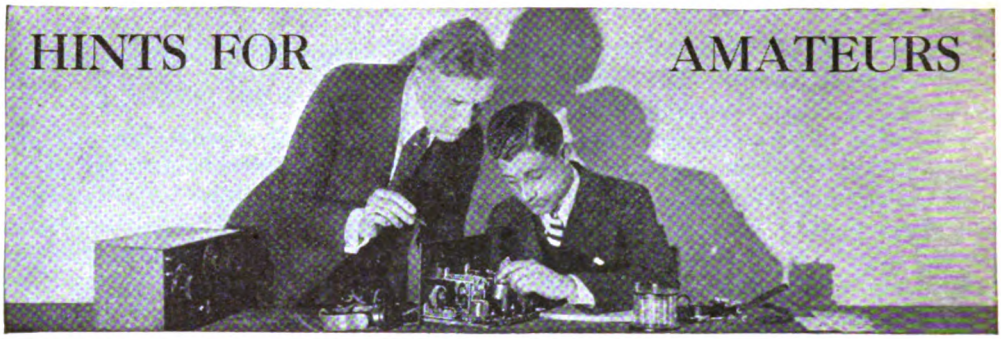

Most instructions for erecting single-wire antennas provide for cutting the wire at the insulator nearest the house, and then urge precautions against a bad connection between antenna and lead-in. Often this difficulty can be obviated by purchasing enough wire, in one piece, to reach from the far support to the set, or at least inside the house, so that no joints are exposed to the weather. Attach the far end of the wire first, then put the other end through the house insulator, draw the wire taut, and give it a few turns around itself before it is continued as the lead-in.

Inasmuch as the lead-in should be kept several inches from the side of the house, and insulated where it enters the building, a bare wire serves just as well as one that is covered. When, for the sake of appearance, an insulated wire inside the house is desirable, the junction between bare and insulated wire can easily be soldered, or kept clean if joined otherwise.

A small single-pole, single-throw knife switch, costing about 25 cents, makes this connection conveniently, and affords additional protection against lightning when an automatic arrester is used outside.

* * *

When loading up the old DX receiver (described in the January issue of Popular Radio) for reception at the higher wavelengths (lower frequencies) that are now used by some of the broadcasting stations, the following suggestions will be found of value:

1. Remove the secondary condenser from its place and connect it in parallel with the antenna coil.

2. Remove the antenna condenser and place it where the secondary condenser was first connected.

3. Join the two wires together which were first connected to the antenna condenser.

4. Place a .00025 mfd. mica fixed condenser across the terminals of the variometer in the plate circuit.

The effect of No. 1 is to replace the .001 mfd. series condenser in the antenna circuit with a .0005 mfd. shunt condenser. This materially increases the antenna wavelength range *upwards*.

The effect of No. 2 is to increase the secondary capacity from .0005 mfd. to .001 mfd. This boosts up the secondary wavelength range.

No. 3 closes the gap in the antenna circuit made by taking out the primary series condenser.

No. 4 raises the wavelength of the plate circuit.

You will find that these hints will bring in the "higher" stations with the same robustness that you used to get the "lower" stations before the wavelength changes went into effect.

* * *

If a regenerative receiver refuses to oscillate properly, when completed, it would probably help if the builder were to try a .00025 mfd. fixed condenser connected across the telephones (if a single tube is used) or across the primary of the first amplifying trans-

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former (if more tubes are used).

* * *

THE wide use and great popularity of the UV-199 radiotron have led to numerous attempts on the part of unscrupulous manufacturers to counterfeit this tube. In external appearance some of the imitations bear such a close resemblance to the genuine tube that it is difficult to detect the difference; even the carton markings, the instruction sheets and the trade-marks are copied.

However, in spite of the resemblance in appearance, the electric characteristics of the counterfeit tubes are very different from those of the genuine UV-199. So far, none of the manufacturers of the illegal tube has been able to duplicate the 60-milliampere filament of the UV-199 and most of the counterfeits require as much as one-fourth of an ampere. Since the voltage of this filament can easily be made 3.0 volts or less, the user of such a tube is often misled by the apparently satisfactory operation when the tube is first lighted, but he soon finds that his dry battery is quickly exhausted and often the tube itself fails in a few hours.

Of course, the easiest way of determining the current required by the filament is to use a milliammeter and a voltmeter, but as such instruments are not in common use among radio experimenters another simple method described below may be used which gives a rough approximation of the filament current.

Connect three new six-inch dry cells in series with the tube to be tested and an ordinary 50-watt, 110-120-volt mazda electric lamp. Figure 1 shows the proper connections. If the filament of the tube that is being tested does not take more than 60 milliamperes, it will light up almost to normal temperature. But, if the tube is not a genuine UV-199 and the filament requires appreciably more than 60 milliamperes, the resistance of the mazda lamp will rise due to the higher current flowing through it, and the voltage on the tube will be so low that its filament will not light. In making the test, be sure that the tube is left in the socket for about 30 seconds to allow the mazda lamp filament to heat up to constant temperature.

When the proper electric instruments are available, an even better test is to use a voltmeter and milliammeter connected exactly as shown in Figure 2. At three volts the current through the filament of a genuine UV-199 radiotron lies between 55 and 65 milliamperes. For this test high-quality instruments *must be used* as otherwise this test is worthless.

A voltmeter that has a full scale reading of 5 is recommended. For the milliammeter use an instrument having a full scale reading somewhere between 100 and 250 milliamperes.

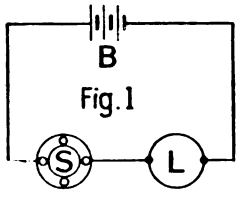

Fig. 1

B – Three New 6" Dry Cells connected in series
S – UV 199 Socket
L – 50 Watt 110-120 Volt Mazda Lamp

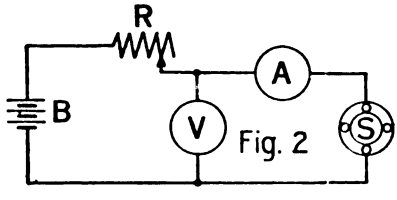

Fig. 2

R – 30 Ohm Rheostat
A – Milliammeter
V – Voltmeter
S – UV 199 Socket
B – Three 6" Dry Cells

The two diagrams shown above in Figure 1 and Figure 2 illustrate the two simple methods for detecting counterfeit vacuum tubes. Figure 1 gives the circuit for the lamp method and Figure 2 gives the circuit for the voltmeter-ammeter method.

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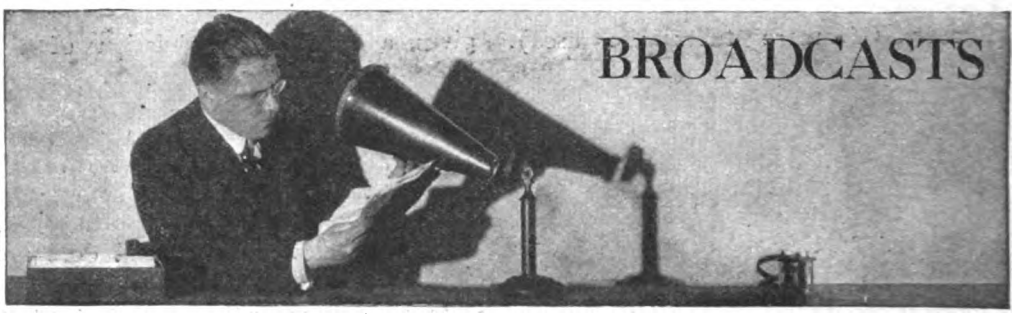

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

The Great Mexican Static Mystery

WHY is it that the special home and playground of the static-making forces is in the mountains of Northern Mexico? All ships' operators agree that the neighborhood of the Mexican coast is saturated almost continuously with squeaks, clicks, roars and scratches. At land stations within Mexican range whenever the direction of static is determined most of it is found to be coming from the direction of these trouble-making hills just south of the border of the United States. There is no obvious reason for this. The Mexican mountains are not especially high nor especially afflicted with thunderstorms. With a few extinct exceptions, they are not volcanic. Whoever can solve the mystery of why this particular part of the earth is so cursed with atmospheric disturbances may go a long way toward solving the other problems of the origin and nature of all static, problems which are still so entirely mysterious. Have our readers who live near the Mexican border any suggestions?

* * *

Advance Seat Sale for Radio Concerts

IN a family that owns only one receiving set, it has been necessary to reduce the receiving schedule to a system of advance reservations. A schedule sheet is kept for each evening hour for a week or two ahead. When Mother reads in the paper that a song she especially wants to hear is to be sent out by a certain station at nine o'clock Tuesday evening she reserves that hour on the sheet. That holds the hour for that station and for her against claims of other members of the family. Sister may reserve Thursday evening for jazz from her favorite band and invite in her friends, secure in the knowledge that no one else will have pre-empted the set that evening for a missionary lecture or the report of a prize fight.

* * *

Yes, Radio Will Help Us Get Bananas

THE United Fruit Company, which supplies most of the bananas to the United States is installing six new radio stations in Central America and at Gulf ports. This will bring the cost of this company's radio system to over $4,000,000, all of it being used to direct the movement of the company's fleet of steamships and thus to control the shipment of bananas and other fruits to the United States.

* * *

Longest One-way Radio Circuit in the World

ONE-WAY traffic is being handled regularly twice each day from the United States Navy station at Cavite near Manila to San Francisco, a distance of 6,221 miles. This is believed to be the longest regular radio circuit in the world.

* * *

Language Study by Radio

THE broadcasting station at Manchester, England, is reported to be supplying its patrons with short programs in French, Spanish, German and Italian, in addition to the regular English program. It is usually admitted that the chief difficulty in mastering any foreign language is lack of opportunity for hearing it spoken regularly. This radio innovation ought to provide an easy means for this without the expense of foreign travel. Many prophets have predicted that radio is to give us a universal language. Perhaps it will, but there is another possibility. When listening becomes regularly international, which it will soon if the improvement of apparatus continues, it may be that radio listeners will learn *all* the languages. Many travelers have remarked that most of the natives of Switzerland, because of constant contact with many languages, speak French, English, German and Italian equally well. There is no reason why this should not be general all over the world. Perhaps it will be when a generation of boys and girls has grown up under the nightly influence of international broadcasting.

* * *

Advertising Towns by Radio

THE first municipality that has attempted to spread its fame by means of its own broadcasting station is Union Hill, New Jersey. A broadcasting transmitter is to be installed in the rooms of the local hook-and-ladder company and the beauties and commercial advantages of Union Hill will be sung nightly over the ether.

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Radio for the Land of Ancient Babylon

A NETWORK of radio stations for local communication as well as for contact with the outside world is to be one of the first developments, it is announced, of the great Chester Concession covering large parts of Asiatic Turkey and Mesopotamia, a concession that was recently confirmed by the new Turkish Government. Thus the oldest civilized country in the world, the land of ancient Babylon, will receive the benefits of the newest invention. Roads that were built by Chaldean kings more than six thousand years ago and that were traversed each day by the king's messengers in the first of all postal systems can still be traced on the desert and along the rivers. But now the messages will move over them in a hundredth of a second instead of in many days.

* * *

Running Your Radio with Wind-power

ACCORDING to the *Scientific American* Mr. A. I. Root, of Florida, has connected his windmill to a battery-charging dynamo and secures thereby enough electricity to run his automobile. Why would not this be a good idea for the radio fan who lives in the country where battery-charging service is difficult to obtain? A small generator could be connected to the family windmill and the batteries charged automatically whenever the radio set was not itself in use.

* * *

A Forecast in Fiction of Radio Broadcasting

LITERARY students have called attention recently to the fact that "Looking Backward," a novel of the future written by Edward Bellamy and one of the best sellers in the early nineties, contains a good description of today's broadcasting. The hero is supposed to have been transported to the year 2000 and in the houses of that period he finds "music rooms" containing nothing but some electrical apparatus and a few switches. By turning a knob or two the householder of that period can have any selection he desires out of a number that are on tap for each hour of the day. Science has anticipated Mr. Bellamy by 77 years. What will radio have led to when the year 2000 really does arrive?

* * *

Successful Radio Navigation of an Airplane

THE air service of the French Government carried out recently an interesting experiment with radio navigation. An airplane flew from Sainte Assise to Tours and back again without any guide beyond the radio compass bearing of the radio station at the former town. The pilot did not look at the ground nor make use of his maps. The bearing of the radio signals was reported to him moment by moment by an assistant and the course was steered by this means alone.

* * *

Looping the Library

A FRENCH amateur, lacking available materials for a revolving loop aerial, solved the problem recently by winding some turns of wire around his revolving bookcase. Entertainment by ear or from the printed page became equally available by turning this radio library to the book or the wave that one happened to desire.

* * *

Radio Batteries Made from Old Automobile Batteries

AUTOMOBILE batteries usually contain three cells connected in series. It frequently happens that an auto battery is discarded because one of the three cells in it has gone bad, the other two being perfectly good. By removing the two good cells, or merely by short-circuiting the one bad one, the radio fan has a perfectly good two-cell battery for use experimentally or on his radio set.

* * *

Atlantic Photo Service

A RADIO PLAYWRIGHT

Clyde Agnew Criswell has the distinction of being among the first, if not the very first author to write a play especially for radio broadcasting—which is developing a technique of its own. Several of his plays have been broadcast from Station WDAR.

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The Natural Wavelength of the Earth

THE size of the earth is such, says Dr. Fournier d'Albe, that it has a natural vibration period of 15 cycles a second, corresponding to a wavelength of 20,000,000 meters. If we could produce a wave of this length we might set the whole earth into electromagnetic vibration just as an organ note will shake the walls and floors of a room. What would happen? It is an interesting problem for the radio theorists to solve.

* * *

Relay Broadcasting to Reach All the World

A SIGNIFICANT experiment has been tried recently both in England and in America; this is the connecting of two or more broadcasting stations by land lines so that the same program can be broadcast simultaneously from all stations. In the United States, WEAF in New York and WCAP in Washington have been linked several times in this way. As many as four stations have been linked on special occasions. In England, three stations of the British Broadcasting Company have been linked experimentally. There is no reason why this cannot be extended. Linkage can be accomplished not only by land lines but by powerful radio waves on a longer wavelength. It is not impossible that before long we may have special programs on the air simultaneously, not only in all parts of the United States but over all parts of the civilized world.

* * *

Radio Fog Signals That Give Both Distance and Direction

THE familiar radio compass that informs a fog-bound ship of the direction of selected shore stations has been supplemented on the Maas lightship off the coast of Holland by a sound-transmitting device which gives the ship captain his air-line distance from the lightship as well as his direction. A radio wave through the ether and a special sound wave through the water are sent out simultaneously from the lightship. The ships off shore can pick up both. The radio signal gives the direction in the usual manner and the length of time that the sound signal lags behind the radio signal gives the distance. The radio signal is, of course, practically instantaneous while the sound wave requires a little over a second to travel each mile.

* * *

Naming the Radio Baby

A RECENT arrival, Master Wallace Gordon Yadon, has been named for WGY. Now is the time for some Hottentot or other gentleman possessed of a clicky, stick-breaking language to name his baby after static.

From a photograph made for POPULAR RADIO

RINGSIDE SEATS AT THE RECEIVING SET

The next-best-thing to a ticket to the famous Dempsey-Firpo boxing contest for the world's championship was an invitation from a radio fan to listen-in on Major J. Andrew White's thrilling blow-by-blow report of the encounter. The Technical Editor of POPULAR RADIO *entertained a whole neighborhood by means of his loud-speaker; this picture shows the crowd beginning to gather.*

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

European Broadcasting Stations that You May Hear

THE receipt of American broadcasting in Europe having become a frequent occurrence, American enthusiasts are attempting more and more actively to return the compliment and receive the European stations here. There is one serious difficulty, that of time. London time, for example, is five hours faster than New York time.

This means that the broadcasting wave from Europe must cross a broad belt of sunlight, with consequent transmission troubles. It means, also, that the hours when European concerts have to be listened for are either the hours of the American working day or are those early in the morning when even the most enthusiastic fans are apt to have exchanged their earphones for the pillow.

Here are some of the main stations that now broadcast more or less regular material, with their wavelengths and brief notes of the usual program hours:

The times given are Eastern Standard Time (New York time). For Central Time (Chicago) subtract one hour; for Mountain Time (Denver) subtract two hours; for Pacific Time (San Francisco) subtract three hours. To compare the time in Europe, the time of transmission of the programs, add five hours to these figures for stations in England, France, Belgium, Holland and Spain. This gives Greenwich Standard Time, which is official in these countries. The time in Germany, Denmark, Switzerland, Czeko-Slovakia and Italy is an hour earlier still; for stations in these countries add six hours.

353 meters, Cardiff, Wales, 5WA. This has the shortest wave of any of the European stations. It is one of six stations conducted in the British Isles by the British Broadcasting Company, which has a monopoly of broadcasting in that country. The other British stations follow. All of them give programs at the same hours: week-days from 10:30 to 11:30 A.M. and from 12:00 noon to 5:30 P.M. (New York time); Sundays from 3:30 to 5:30 P.M. The programs are separate for each station.

369 meters, London, England, 2LO. The main one of the British stations (see above). In addition to the same program hours as the other stations, 2LO gives a program at 6:30 to 7:30 A.M. on week-days and at 10:00 A.M. on Sundays.

385 meters, Manchester, England, 2ZY. A British station.

400 meters, Newcastle, England, 5NO. A British station.

415 meters, Glasgow, Scotland, 5SC. A British station.

420 meters, Birmingham, England, 5IT. A British station.

450 meters, Station of the Telegraph School at Paris, France, *(École superieure des Postes et Telegraphes).* Concerts at 2:30 P.M. Tuesdays and Thursdays and from 8:30 A.M. to about 1:00 P.M. on Saturdays. Announcements in French. (Paris is pronounced "pah-ree.")

460 meters, Station "Radiola-Riviera" at Nice, France (pronounced "neece"). News (in French) and concerts at somewhat irregular times, usually about 7:00 A.M., 12:00 noon and 4:00 P.M.

900 meters, Geneva, Switzerland (pronounced "Zhen-ayve"), HB1. Daily concert, announcements in French, 12:00 noon to 2:30 P.M. A 900-meter wave is also used for the radiophone system of most of the European lines of passenger airplanes, and listeners may hear this occasionally.

1,000 meters, Kbel, near Prague, Czeko-Slovakia (pronounced "kbail"). Weather report, news and concert, daily, 1:20 P.M. In German and Czek.

1,050 meters. This is the wavelength used by all the stations in Holland. Material is mostly in Dutch, sometimes in French or English. Following are the stations: The Hague, Velthuyzen station (pronounced "felt-high-sen"), PCKK, concert, Fridays, 2:40 to 3:40 P.M. The Hague, Heussen station (pronounced "hoy-sen"), PCUU, concerts, Tuesdays, 1:45 to 4:00 P.M. and Sundays, 3:40 to 4:40 P.M. The Hague, station PCGG, concerts Sundays, 9:00 to 11:00 A.M. and Mondays and Thursdays, 2:40 to 3:40 P.M. Amsterdam, station PA5, concert and news, Wednesdays 2:10 to 3:10 P.M. and irregularly on other days. Ijmuden (pronounced "yim-mee-den"), station PCMM, concerts Saturdays, 2:40 to 3:40 P.M.

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1,100 meters, Brussels, Belgium, BAV, (pronounced "brew-sell"). Daily weather report (in French), 7:00 A.M. and 11:00 A.M. Concerts Tuesdays and Thursdays at 4:00 P.M. and Sundays at 1:00 P.M.

1,300 meters, Haren, Belgium, OPO. The same weather report as from the Brussels station at same hours.

1,350 meters, Lausanne, Switzerland, (pronounced "law-sahn"). Daily concerts at somewhat variable hours, usually beginning about 12:00 noon.

1,780 meters, Paris, France, "Radiola" Station, SFR. The most popular station in France. Concerts and general programs (in French), week-days 6:00 A.M., 11:15 A.M., 3:00 to 4:00 P.M.; Sundays 8:00 to 10:00 A.M. and 3:00 to 4:30 P.M. Special dance music 4:00 to 5:00 P.M., Thursdays and Sundays. News, 2:45 P.M. week-days. Stock exchange quotations, 11:00 A.M. week-days.

1,800 meters, Prague, Czeko-Slovakia, (pronounced "prah-g"), PRG. Weather and news somewhat irregularly, usually about 2:00 A.M., 5:00 A.M. and 10:00 A.M. This station also broadcasts on 4,500 meters. (See below.)

Francis Dickie

A PORTABLE SET 800 MILES FROM CIVILIZATION

Until last summer surveyors who are mapping the sub-Arctic regions were completely cut off from civilization. Now, however, they are equipped with portable radio sets; the one shown above was photographed on the north shore of Great Slave Lake, British Columbia—800 miles in airline from the nearest city.

2,200 meters, Madrid, Spain, (pronounced "mah-dreed." The word for Spain in Spanish is "es-pahn-ya"), EGC. News and notices, in Spanish, week-days, 6:00 to 8:00 A.M.

2,400 meters, Lyngby, Denmark (pronounced "leeng-bee), OXE. Weather reports and news, in Danish (occasionally in English), 3:30 A.M., 9:40 A.M. and 2:45 P.M. daily. Concerts, 1:30 to 2:45 P.M. week-days.

2,600 meters, Paris, France. Eiffel Tower station. FL. Weather reports, 1:40 A.M., 6:15 A.M., 1:20 P.M. and 5:15 P.M. daily. Stock exchange quotations at 9:30 A.M. week-days. Concert, 12:10 P.M. daily and frequently also in the evening, 3:00 to 7:00 P.M., New York time.

2,700 meters, Berlin, Germany (pronounced "bear-leen"), I.P. Daily program, in German, 6:00 to 7:00 A.M. This station also broadcasts on 4,000 meters. (See below.)

2,930 meters, Eberswalde, Germany (pronounced "a-bears-valld-eh"). Daily programs in German, 7:00 to 8:00 A.M., 2:00 to 3:00 P.M. Special concerts Tuesdays and Saturdays, 12:30 to 1:30 P.M.

3,000 meters, Budapest, Hungary, HB. News, in Hungarian and German, week-days, 6:30 to 7:30 A.M.

3,100 meters, Lyons, France (pronounced "lee-ong"), YN. News (in French) and phonograph selections, week-days, 4:45 to 10:00 A.M.

3,200 meters, Rome, Italy (pronounced "roam-ah"). Concert daily, 4:00 to 5:30 A.M.

4,000 meters, Berlin, Germany. (See under 2,700 meters, above.) On 4,000 meters news (in German) is broadcast daily 1:00 A.M. to 2:00 A.M., 6:00 to 7:30 A.M. and 10:00 A.M. to 12:30 P.M. Music is broadcast Sundays between 5:00 and 6:00 A.M.

4,500 meters, Prague, Czeko-Slovakia. (See under 1,800 meters above.) On 4,500 meters concerts are broadcast at 4:00 A.M., 9:00 A.M. and 4:00 P.M.

For American listeners the first station available in the morning is Berlin, with news on 4,000 meters; this comes in about 1:00 A.M. At 1:40 A.M. comes the first weather report from the Eiffel tower at Paris on 2,600 meters. The Prague weather report is due about 2:00 on 1,800 meters and is followed by the Danish one from Lyngby at 3:30 on 2,400 meters. The first music is due from Prague about 4:00 A.M. on 4,500 meters. Lyons, on 3,100 meters, comes in about 4:45 A.M. and Rome, on 3,200 meters, about 4:00 A.M.

The programs on waves below 1,000 meters begin at 6:30 A.M. with the early London program on 369 meters. The two short-wave French stations, the Radiola Riviera at Nice and the Telegraph School at Paris, come in at 7:00 and at 8:30, respectively. The best programs available below 1,000 meters are those of the British stations, due at 10:30 A.M., 12:00 noon and 3:30 P.M.

After you get home in the evening you have a chance at the late concerts from the Eiffel tower on 2,600 meters. Sometimes these last until 7:00 P.M. but they are not broadcast every day. The British programs, on 353 to 420 meters, last until 5:30 P.M.

On Sundays there is a long list of stations; notably the British programs from 3:30 to 5:30 P.M.; the concert from the Eiffel tower (2,600 meters) at 12:10 P.M.; the Paris "Radiola" concerts on 1,780 meters from 8:00 to 10:00 A.M. and from 3:00 to 4:30 P.M.; the Berlin concert on 4,000 meters from 5:00 to 6:00 A.M. and on 2,700 meters from 6:00 to 7:00 A.M.; two concerts from The Hague, PCGG at 9:00 A.M. and PCUU at 3:40 P.M., both on 1,050 meters; Geneva at 12:00 noon on 900 meters and Brussels at 1:00 P.M. on 1,100 meters.

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International

A Real Portable Receiving Set

During the period of the Leipzig Fair this distinctly modernized "sandwich man" paraded the main streets of the town, with a four-tube radio set hanging on his breast and a loop antenna and loudspeaker on his back. Presumably the local broadcasting station transmitted entertainment that was designed to attract visitors to the displays of 13,000 exhibitors.

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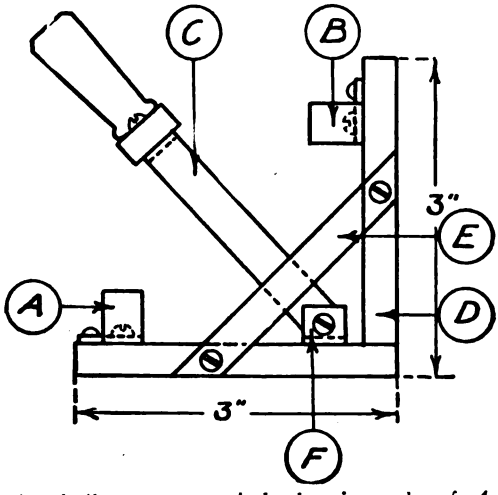

A rebuilt antenna switch that is made of A and B, the "send and receive" contacts, respectively; C the switch blades; F the hinge contacts and E the brass strips to hold the wooden base D rigid.

A Home-made Switch

HERE is a clever little labor-saving stunt that was devised by an amateur who submits it to the readers of POPULAR RADIO:

I found that the blades of the ready-made D.P.D.T. switch I was using were too far apart for convenience in operating. So I took the switch apart and rebuilt it with the blades only two inches from each other, as shown in the diagram. I no longer had to operate from an awkward position.

—DOUG TREMPER

Unexplained Phenomena of Transmission at Sunrise and Sunset

FROM a thoroughly experienced and exceptionally observant operator who is in charge of the U. S. Air Mail Radio Station at Salt Lake City, Utah, come these pertinent observations that have a bearing upon the Heaviside Layer Theory; they were prompted by an article "Why We Cannot Send So Well by Day" that appeared in the September issue, which contained the statement:

"We have it on the authority of Marconi that transmission is at its worst 'When the line of the sunrise or the sunset is between the two stations.'"

If I may be pardoned for challenging a statement by so eminent an authority, I would like to state that I have found this to be only partly true. In fact, for a short period at sunrise and at sunset, I have found it possible to do better radio work than at any other time of day. These short periods, however, are invariably preceded by periods during which east-and-west communication is practically impossible. From this, it appears to me that Marconi's statement, while not incorrect, is not complete.

During more than two years past, I have communicated daily with east-and-west stations of the U. S. Air Mail Service; this communication starts before sunrise and ends after sunset, and I have noticed on numerous occasions that the so-called sunrise and sunset fading periods are affected differently on different wavelengths at the same instant, and also that stations at various distances—even though in the same direction—are not affected simultaneously, as would be supposed.

The signals from stations to the east of us are affected more by the sunrise fading period than at sunset, whereas stations west of us show the greatest effect during sunset.

Furthermore, stations which may be receiving my station and reporting that my signals are extremely weak due to sunset fading, can be copied here at the same instant with usual ease, and when signals from that station are weak here, they receive my signals O.K.

A most peculiar phenomenon has been noticed with the Reno station during the evening fading period. Signals from that station are generally very good all day long here in Salt Lake City, especially during winter time. At the fading period, however, Reno's signals become weaker and weaker until they become absolutely inaudible. Ten minutes is generally the time required from the time signal-fading is first noticed until the lowest ebb is reached. Immediately the signals then become extremely loud and clear—louder than at any other time of day, gradually dropping again to their normal strength.

This seems to me to partially confirm that phase of the "Heaviside Theory" that has to do with the so-called "blanket of ionization" which travels westward with the sun; however, the fact that the increased signal strength is not noticed directly before the sunrise fading period, leaves an additional explanation necessary, for in the evenings when the "blanket" has passed a station to the west of us, or in the mornings, when the "blanket" has not quite reached a station to the east of us, it should act as a reflector, directing the signals to us with added strength such as is actually noticed in the case of stations west of us in the evenings.

My observations were all taken on wavelengths of from 2,500 to 4,000 meters. During the coming winter, however, I will also work on wavelengths from 150 to 600 meters, and I will watch, with anticipation, any change in the fading characteristics on these waves which may vary from the longer ones.

—PHILIP L. COUPLAND

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Wire Antennas Better Than Copper Ribbons

FROM a Philadelphia reader comes this pertinent bit of information, prompted by the constantly recurring suggestion that the standard copper-wire antenna may be improved by copper in other forms:

While many of the writers on radio recommend the use of a copper ribbon for an antenna, especially for use on crystal sets, because of its greater "skin effect," the Bureau of Standards at Washington considers the disadvantages of such an antenna to be greater than its benefits. In a letter to a Philadelphian, William T. Innes, in response to a request by him for information concerning the copper-ribbon antenna, the Bureau wrote that it did not recommend such an antenna for receiving purposes, as little advantage would be gained by its use. Such an antenna is subject to excessive stresses in sleet and wind storms and would, therefore, not be as permanent as the ordinary single-wire antenna.

—BERNARD KLIMAN

Practical Experiments with Coils

THE stimulating effect of our articles is aptly illustrated by the following observations that are not only of interest but of value to amateurs:

The very interesting as well as valuable article which appeared in the May, 1923, issue of this magazine written by no less an authority than Sir Oliver Lodge, excited my curiosity; it made me anxious to learn just what the difference was between coils having the same number of turns of the same sized wire but of different shapes. I therefore constructed a coil having the following specifications:

25 turns No. 25 S.C. enamel wire
4 inches diameter.

The coil was then treated with an insulating solution so that it would be possible to bend the coil into any shape desired. It was connected to a .001-mfd. condenser and a crystal detector and a pair of telephone receivers.

A Kolster wavemeter was used as the "driver."

Readings were taken on five different settings namely, 170, 210, 275, 365 and 450 meters. The results are shown in the table below. The round coil gave the maximum inductance (self-induction), the D-shaped coil slightly less, while the figure eight coil had considerably less inductance.

The star-shaped coil had less than any of those tested.

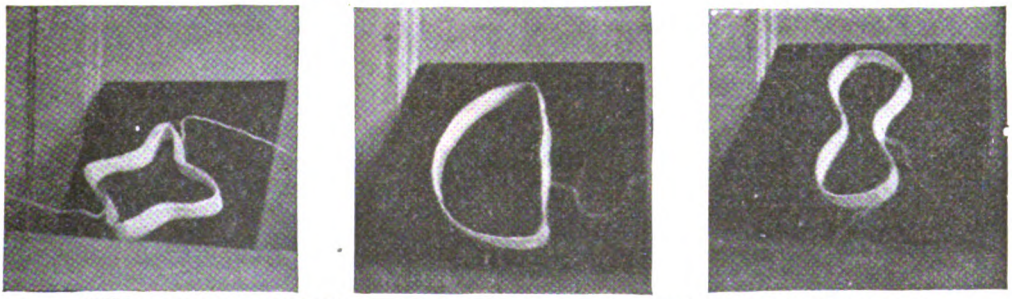
Unfortunately the capacity sheet was not furnished with the wavemeter and therefore it was not possible to take distributed capacity readings.

The following is a list of the wavelengths for each coil together with the condenser settings:

Coil	*Wavelength*	*Condenser setting in degrees*
O-shape	170 meters	13
D-shape	" "	16
8-shape	" "	20
Star-shape	" "	22
O-shape	210 meters	22
D-shape	" "	26
8-shape	" "	35
Star-shape	" "	38
O-shape	275 meters	44
D-shape	" "	47
8-shape	" "	56
Star-shape	" "	64
O-shape	365 meters	73
D-shape	" "	76
8-shape	" "	92
Star-shape	" "	100
O-shape	450 meters	115
D-shape	" "	118
8-shape	" "	140
Star-shape	" "	160

This data will permit the readers of this magazine to make a mental picture of what that eminent authority had to say in the May, 1923, issue, on pages 354 to 357 inclusive.

—EDWARD T. JONES



WHAT SHAPE OF COIL WILL GIVE THE MAXIMUM INDUCTANCE?

Here are three pictures of a coil which was bent into a star shape (shown at the left), a D shape (in the center) and a figure-8 shape (at the right). The coil was found to have the greater inductance when it was left round, less in the D shape, still less in the figure-8 shape, and least of all in the star shape.

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"Secret" Radiophone Messages

"SECRET communication" by radio is already an established fact, as was described in the May number of POPULAR RADIO which included a description of M. Edouard Belin's remarkable apparatus that literally "scrambles" radio code messages on the transmitting device and re-assembles them on the receiver. Now comes an invention that does somewhat the same thing for radio telephone communication.

The radio telephone link between Los Angeles and Catalina Island, 30 miles off the coast of California, has set a new record in the history of communication; it is the scene of the first trial on a commercial basis of a private radio telephone system insuring secrecy to its users.

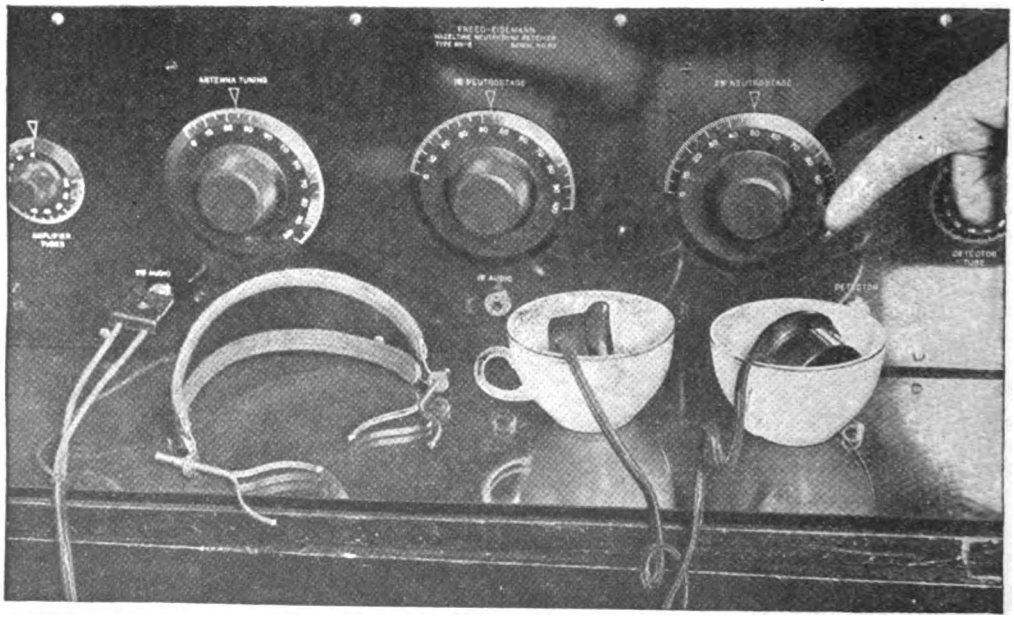
This radio "talk bridge" across the 30-mile gap of water separating Catalina from the California coast is unique in many respects. It was designed and installed in 1920 to give two-way talk between the mainland and an island 30 miles at sea, and has "proved in" on a commercial basis, giving satisfactory transmission throughout the year.

The wireless link connects Catalina Island not only with Los Angeles but also, through the trunk lines of the telephone system, it connects the island residents with every commercial center in the United States. After the laying of the telephone cable between Key West and Havana, the longest telephone circuit on record was that set up between Catalina Island in the Pacific and the island of Cuba in the Atlantic. This circuit was remarkable for its character as well as for its length.

Heretofore talks over the Catalina Island link while clear and understandable to those using the service, have also been picked up by amateur radio receiving stations in the neighborhood, but the privacy system which was designed by the American Telephone and Telegraph Company has remedied this situation. It is not claimed that the new system is *absolutely* secret, but at least privacy has been obtained, so that no one will inadvertently overhear the conversations.

While any one familiar with this system, and possibly an ingenious person not familiar with it, might devise a set which *could* listen to the system, such a set would be much more complicated than the ordinary set, and the added complication would be of no value except for picking up transmission over this system. It is, therefore, not likely that many people will undertake this work.

Such a privacy system may be compared to a lock and key. A person relies upon a lock to secure his house and other property and is not much troubled by the possibility of a thief breaking in to steal. However, this is always a possibility. The privacy system presents an analogous case. For all practical cases it insures the requisite privacy to a radio telephone conversation, but it does not make impossible the designing of a special set near enough like the receiving sets used in the system itself, to transform the messages into more or less intelligible form.



By placing each of your telephone ear-pieces in a teacup, you can make a satisfactory loudspeaker—if there is an audio frequency amplifier included in your set.

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A limited number of questions of general scientific interest will be answered each month in this department. Readers are invited to send in questions that have puzzled them—but the selection of questions for answer cannot be guaranteed nor can questions outside the radio field be answered by mail.

Is radio transmission affected by the phases of the moon?

So far as known it is not. Sunlight has a well known effect on radio conditions and it has been claimed that moonlight has a similar influence, though a smaller one. This may be true, but if so the effect is presumably so small that in ordinary cases it is masked altogether by the accidental variations of transmission that come under the heads of fading, atmospherics, and the like.

Why will a nail driven into a live tree make a good ground while one in a dead tree is useless?

Because the live tree has sap in it. The sap is not pure water but contains various salts in solution. This solution is a fairly good conductor of electricity. The dead tree, having no sap in it, is a very poor conductor and will not serve as a ground.

I have seen a mention of something called a "Diode Valve." Is this the same thing as an ordinary vacuum tube?

No. The British name for vacuum tube is "*triode* valve." The *diode* valve is a vacuum tube with only two electrodes, the filament and the plate only, without the grid. These two-electrode vacuum tubes or "valves" were invented by Dr. J. A. Fleming before the three-electrode tube was discovered, and were used for a while both as radio detectors and as rectifiers for alternating currents. They still have some scientific uses but are not much used in radio, the three-electrode tube being much more efficient.

Is it true that some flashes of lightning move from the ground upward to the clouds instead of downward from the clouds to the ground?

As a matter of fact nearly every flash of lightning, if not absolutely every one, moves in *both* directions. The flash is an oscillating discharge. If the first discharge is downward there is an immediate surge back in the opposite direction. The charge may oscillate in this way many times during what seems to be the single flash. The net movement of electrons is, of course, from the negatively charged area to the positive one. The cloud, we believe, is usually positive, so the *net* discharge of electrons after all the back and forth oscillations are over, is usually upward rather than downward.

How is it that radio waves have proved the inside of the earth to be solid instead of molten?

This has been proved by *earthquake* waves, not by radio waves. An earthquake wave is the shock set up in the earth's crust by a quake. It travels through the earth just as the vibration caused by a hammer blow will travel through a steel girder and may be felt at the other end. The speed of these earthquake waves in traversing the earth shows, the scientists say, that the inside of the earth is more rigid than steel. *Radio* waves are now being used experimentally to explore the inside of the earth but so far as we know, no conclusions have been reached in this way.

Why is an electric shock sometimes fatal and sometimes not?

The difference is due, probably, to variations in the path of the current through the

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body and in the length of time it flows. The main damage caused by a current is to the nerves, which are themselves electric in nature and are disorganized, in some way which we do not understand, by strong currents. If the current due to an electric shock does not happen to pass through the nerves or if it flows along them only for a very brief instant the damage done to them is not severe enough to cause death.

Is it possible to break a wine glass by singing at it?

We have never seen it done, in spite of many trials. The idea that it is possible arises from the fact that if you sound near a wine glass the particular musical note to which that glass happens, by virtue of its material and shape, to be tuned, the glass will vibrate, just as two tuning forks of the same note or two radio circuits of the same frequency will do. These vibrations induced in the glass *might* break it but only, we imagine, if it was very fragile and tuned with great exactness.

How has the speed of ether waves been measured?

The most exact measurements have been made with light waves. A beam of light is sent past the edge of a revolving gear wheel so that each tooth of the wheel, as it passes, makes a little shadow. Then this intermittent light beam is sent off to a distant station, where a mirror reflects it back again. By measuring just how far one tooth of the wheel has moved while the light was on its way to the other station and back the speed of the light is calculated. The speed of radio waves cannot be measured in this way but comparisons of the time signals from American and European stations prove that the speed of radio is the same, approximately at least, as the speed of light, that is, 186,326 miles a second.

Why do different substances differ in specific gravity?

For one of two reasons; either because the atoms themselves are heavier or because they are closer together. The heaviest atoms known are those of uranium, but there are several substances that are heavier in bulk. The heaviest known substance is the metal called osmium. A cubic inch of this will weigh nearly twice as much as the same volume of lead.

What is meant by "the C. G. S. units?

This is scientific shorthand for the system of units of length, weight, electricity and everything else based on the three fundamental units of the centimeter for length, the gram for weight and the second for time. The foot-pound, for example, is not a C.G.S. unit, since it involves the foot instead of the centimeter as a unit of length. The corresponding C.G.S. unit is the kilogram-meter. The customary electric units do not belong to the C.G.S. system. The C.G.S. ones are much used in scientific research work but seldom elsewhere.

How can a storage battery store up electricity without accumulating so high a charge as to be dangerous?

A storage battery does not really store electricity as such. If it did the voltage would rise to very high values, just as when electricity accumulates on a condenser. What happens in a storage battery is that the charging current deposits a chemical on one of the plates of the battery. When you stop the charging current and connect the wires to the circuit through which you want current to flow, some of this chemical dissolves again in the battery acid and produces some electricity. What is stored in the battery is really this chemical, not electricity itself.

Is it possible to measure the voltage of an electric charge by the distance that a spark will jump?

It is possible to do so with fair accuracy if the sparks are between balls or other rounded objects, not pointed or sharp-cornered ones. For the best results the balls should be as large or larger than the gap between them. The following table gives the approximate voltages for sparks of different lengths between four-inch balls.

one-tenth inch	8,000 volts
one-quarter inch	20,000 volts
one-half inch	40,000 volts
one inch	70,000 volts
two inches	125,000 volts
three inches	165,000 volts
four inches	200,000 volts

Above about 200,000 volts the readings by this method are not sufficiently reliable.

Some electrical apparatus is referred to as having a power of so many "kva." Does this mean the same as kilowatts?

Not exactly. If you are dealing with direct current the power of a dynamo or motor is measured by the product of the current (in amperes) and the voltage (in volts). This gives you watts, thousandths of a kilowatt. This is a simple calculation. But with alternating current the calculation of the power in watts or kilowatts is less simple. The product of volts and amperes is not always exactly equal to the watts of power. So this product, which remains a convenient way to describe the apparatus, is given a symbol of its own, "kva." This means "kilo-volt-amperes," one thousand times the product of volts and amperes. 1,000 kva means a machine that is delivering (or using) 1,000 amperes at 1,000 volts, or 10,000 amperes at 100 volts, and so on.

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The size you want— the insulation you need

YOU don't need to wait while your panel is cut to order when you get ready to build your radio set. Just go to your dealer and ask for a Celoron Radio Panel. He will give you, without a moment's delay, the exact size you want. And — what is more important — you get the proper insulation for successful results in radio receiving.

Celoron is recognized by radio experts as the best material for insulation purposes. Its high dielectric strength makes it the ideal panel material.

Used by leading manufacturers

Many of the leading manufacturers of radio equipment use Celoron in making their standard parts. It is approved by the U. S. Navy Department Bureau of Engineering and the U. S. Signal Corps.

Celoron Radio Panels come ready-cut in eight standard sizes, selected to meet the needs of the set-builder. Each panel is neatly wrapped in glassine paper to protect the handsome surface.

Celoron panels are readily worked with ordinary tools at home. They are easy to machine, saw, drill, and tap.

Ask a radio dealer for one of the following standard sizes:

1—6 x 7 x 1/8	5— 7 x 18 x 3/16
2—7 x 9 x 1/8	6— 7 x 21 x 3/16
3—7 x 12 x 1/8	7— 7 x 24 x 3/16
4—7 x 14 x 3/16	8—12 x 18 x 3/16

We also furnish Celoron in full sized sheets and in tubes, and can cut panels in special sizes when desired. If your dealer hasn't yet stocked Celoron panels, ask him to order for you, or write direct to us, indicating by number the size you want.

Send for free booklet

"Tuning in on a New World" is the title of a booklet we have prepared especially for the radio fan. It contains a list of the leading broadcasting stations in the United States and Canada, an explanation of symbols used in radio diagrams, and several popular radio hook-ups. This booklet will be sent without charge, on request.

To radio dealers: Write for special dealer price list showing standard assortments

Diamond State Fibre Company

BRIDGEPORT (near Philadelphia) **PENNSYLVANIA**

BRANCH FACTORIES AND WAREHOUSES
BOSTON CHICAGO SAN FRANCISCO

Offices in Principal Cities

In Canada: Diamond State Fibre Company of Canada, Limited, 245 Carlaw Ave., Toronto

CONDENSITE
CELORON
STANDARD RADIO PANEL

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Brandes

SUPERIOR
$6.00
NAVY TYPE
$8.00

Matched Tone
TRADE MARK REG. U.S. PAT. OFF.
Radio Headsets

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Brandes

New — the *Table-Talker!*

New! New in the quality of its performance. New in the beauty of its appearance. New in the moderation of its price.

Another Brandes achievement—worthy to stand beside the now famous *Matched Tone* Headset. Brandes engineers have worked more than two years to make its tone strong, mellow, true.

Attractive — because an expert decorator suggested its simple lines and neutral brown finish.

The perfect gift for every radio fan. The easiest way to transform a one-man set into a joy for all the family!

All Brandes products are sold under a money-back guarantee.

C. BRANDES, Inc. New York

$10

Table-Talker

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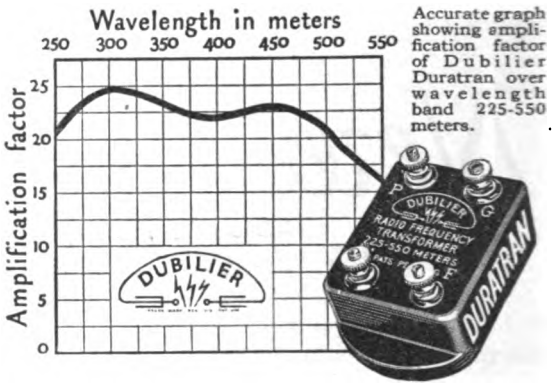
DUBILIER

Radio-Frequency Amplification over all wave lengths



Accurate graph showing amplification factor of Dubilier Duratran over wavelength band 225-550 meters.

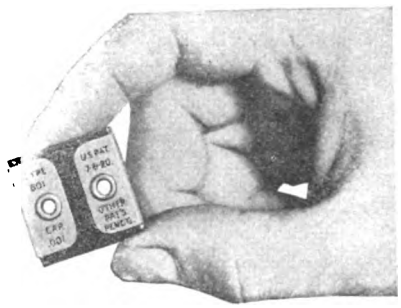
The Dubilier Duratran is the supreme radio frequency transformer.

It amplifies twenty times over the wave-length band 220-550 meters and is therefore adapted for receiving on all the broadcasting stations *equally well.*

The curve shows you exactly how uniform is a Duratran amplification over the standard broadcasting wavelength band.

Price $5.00.

The Biggest Little Thing in Radio



Dubilier Micadons are fixed mica condensers, permanent in capacity.

They have been adopted by the leading radio manufacturers and by discriminating amateurs.

Dubilier Micadons are made in many styles and capacities to meet any circuit requirement.

See if your set is equipped with Micadons. If it isn't, your tubes are probably oscillating too much. Your set is not receiving at its best.

Price 35 cents to $1.50, depending on style and capacity.

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DEVICES

The Ducon in a Light-Socket

takes the place of the antenna or loop

The Dubilier Ducon is the standard socket-plug. Four hundred thousand are in successful use.

Simply screw the Ducon in any convenient lamp-socket, and the broadcasting station comes in strong and clear.

No lightning arresters or switches are needed.

Tuning is sharper than with the usual antenna.

If unsatisfactory, your money will be refunded after five days' trial.

Price $1.50.

Bulletin PR, a simply worded, accurate description of radio-frequency amplification, with valuable hook-ups, will be sent you on request.

Dubilier Condenser & Radio Corporation

48-50 West Fourth Street, New York

BRANCH OFFICES

Huntington, W. Va., Atlanta, Ga., Pittsburgh, Pa., Chicago, Ill., St. Louis Mo., Los Angeles, Cal., Washington, D. C.

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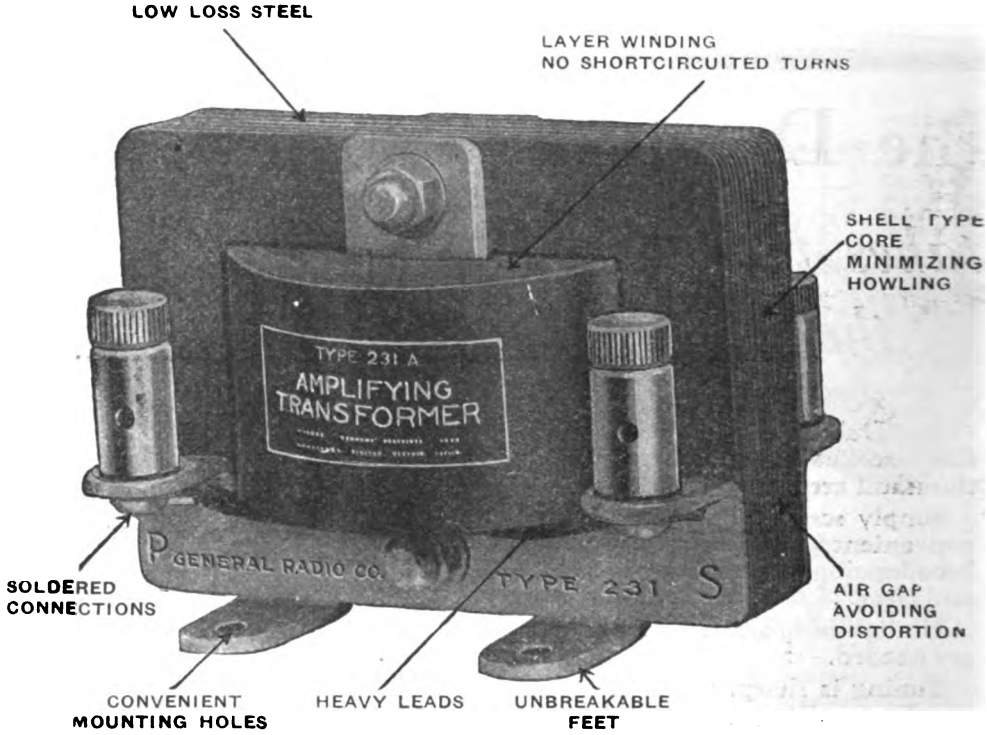
Quality Amplification



High mu or low mu, when you amplify you must be sure that you do not distort because maximum amplification by itself does not necessarily mean satisfaction. You should seek maximum amplification with minimum distortion over the entire audio frequency range.

This problem has been studied for nearly a decade in our laboratory. Its result is expressed in our Type 231A amplifying transformer. Not only has this transformer a high amplification factor but the amplification is nearly uniform throughout the audio range. This flat curve makes it unnecessary to employ the cumbersome method of using different makes of transformers for 2 stage amplification. Use an engineering designed transformer. It costs no more

Turns ratio . . . . . 3.7 to 1
Impedance ratio . . . . . 10 to 1

PRICE, COMPLETELY MOUNTED....$5.00

Send for free educational folder—"Quality Amplification," and Radio Bulletin No. 916

General Radio Company

Manufacturers of Electrical and Laboratory Apparatus
Massachusetts Avenue and Windsor Street
CAMBRIDGE ∴ ∴ MASSACHUSETTS

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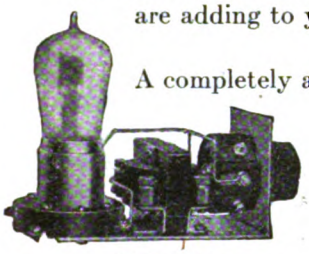
GUARANTEED RADIO

Results can only be relied on with standard make instruments that are guaranteed by a reputable manufacturer. The General Radio Company has been guaranteeing its instruments for nearly a decade. When you are adding to your set consider these guaranteed instruments.



TYPE 300

A completely assembled and wired audio frequency amplifying unit for very little more than the price of the parts. This unit is ready for external connection, and is adapted to table or back of panel mounting.

Type 300A Unit for WD-11 Tubes..... $7.50
Type 300C Unit for UV 199 Tubes..... 7.75
Type 300D Unit for Standard Base Tubes. 8.25

TYPE 156

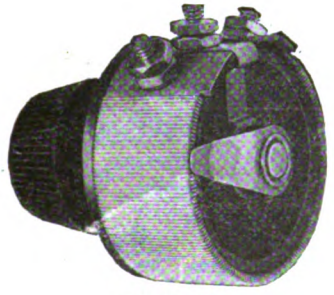
A vacuum tube socket with positive contact springs. Base of real bakelite. Wall of heavy brass with high polished nickel finish. Will carry current of 5 watts without arcing.

Type 156, Vacuum Tube Socket,..... $1.00

TYPE 299

A socket for UV-199 Tubes. Of moulded bakelite with stiff phosphor bronze springs.

Type 299, Vacuum Tube Socket..... $0.75



TYPE 301

A wire wound rheostat of real quality. Base of bakelite. Resistance wire finely wound on specially treated fibre strip.

Type 301 Rheostat—Resistance 30 ohms. $1.25
Type 301 Potentiometer—Resistance 200 ohms..... $1.25

General Radio Company

Manufacturers of Electrical and Laboratory Apparatus
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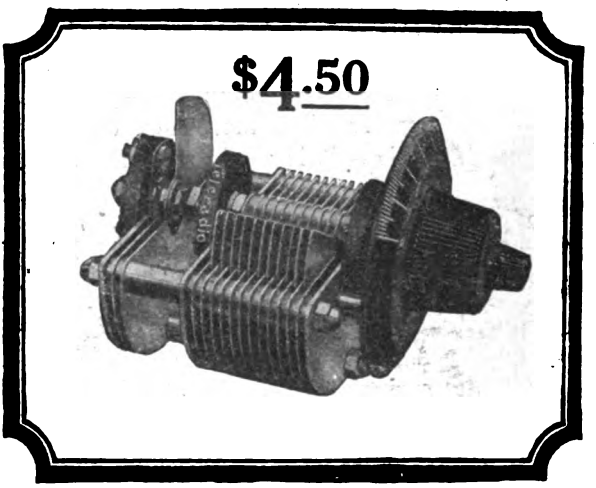
Teleradio



Reliability in Your Condenser

The principle factors that brand reliability in condensers are sturdiness and accuracy.

Teleradio Vernier Condensers are well worthy of these qualities. The plates are extra heavy polished hard aluminum that will not warp. Rigid construction throughout insures perfect plate alignment. Special locking feature prevents short circuiting of vernier and provides permanent and perfect contact. Capacity is accurate and constant. All metal parts nickel plated. Built for base or panel mounting. Guaranteed electrically and mechanically perfect.

Truly, tuning is a pleasure with Teleradio Condensers.

At your dealers or send direct.

SUPER-SENSITIVE

Teleradio head phones accurately reproduce the faintest signals on either crystal or tube sets, and bring in voice or music with wonderful tonal quality. Equally successful for local or long distance work. Built on sound engineering principles and are so sturdy they will stand up under unusual usage.

2000 ohm	$5.50
2200 ohm	$6.00
3000 ohm	$7.00

TELERADIO ENGINEERING CORP.
488-490 Broome Street **New York**

VERNIER CONDENSERS 23 plate $4.50. 43 plate $5.50
VARIABLE CONDENSERS 3 plate $2.00. 11 plate $2.50. 23 plate $3.00. 43 plate $4.00
RHEOSTATS (6 and 30 ohms) $1.00 LIGHTNING ARRESTER $1.00

TELERADIO PRODUCTS

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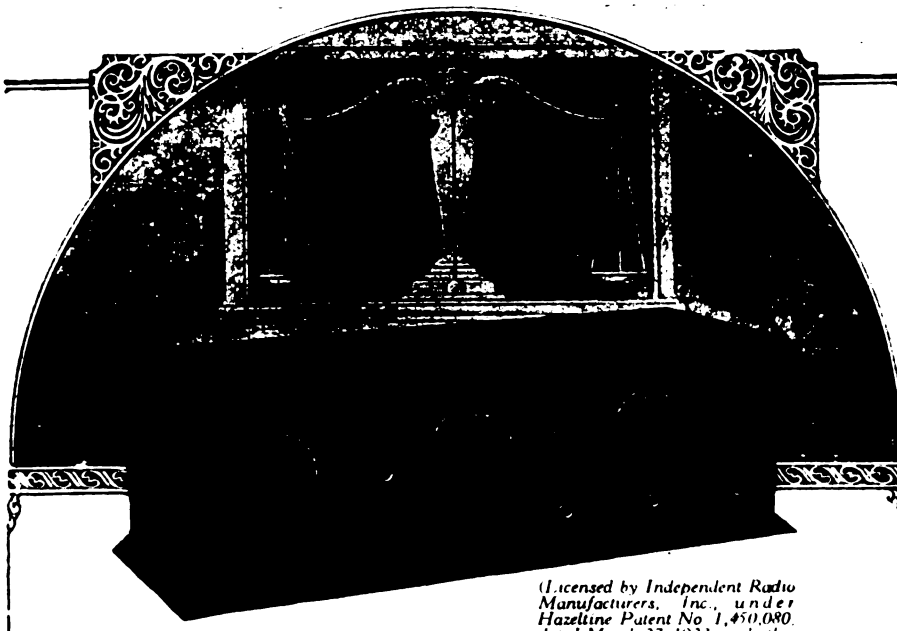

(Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No 1,450,080, dated March 27, 1923, and other patents pending.)

THE cherished ideal of radio scientists—reception without limitations, yet simple to use as a telephone—crystalized in this amazing receiver.

The Eagle
Balanced-Neutrodyne
RADIO RECEIVER

Balanced tube capacities, as infinitely scrupulous as the balance of a jewelers' scale, makes *impossible* regeneration, reradiation, static disturbance and all body capacity effects. Therefore, the *Eagle Balanced Neutrodyne Receiver* has greater range, crystal-clear reception and easy, positive operation. As fine reception for the novice, as for the most adept, with the *Eagle Balanced Neutrodyne Receiver*. All tuned circuits. Each receiver individually tested and inspected from beginning to completion. *Quality*, not quantity, production in order to sustain a well-respected reputation. Guaranteed without reservations

Write for Booklet Today!

THE SOAR ABOVE
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TRADE MARK

18 Boyden Place Newark, N. J.

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O'NEIL AUDIPHONE

Knowledge stored up during many years of phonograph reproduction and electro acoustic experience now released to the radio world thru the AUDIPHONE.

"NO radio receiver is better than its reproducer—the loud speaker" The AUDIPHONE puts the human touch into the electrical elements of your receiver. Sturdy loud speaker construction with strong magnetic field absolutely eliminates blast and distortion so prevalent in ear-phone types of loud speakers. Programs created anew in your home exactly as broadcasted from the radio studios. The patented, "External Adjusting" feature enables you to regulate the AUDIPHONE to your individual receiving conditions. Startlingly **real** amplification without extra batteries, transformer or induction coil. Write for illustrated booklet and send us the name of your dealer.

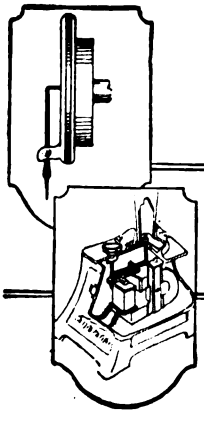
Dealers, Jobbers and Distributors; write for attractive proposition

Complete with 5 foot phone cord.

PRICE

$25.00

No extra batteries required.



Note the similarity of construction between the phonograph reproducer (illustrated in the upper panel) and the reproducer of the O'Neil AUDIPHONE (below): both have a mica diaphragm set in a sound-box chamber and actuated by an elbow stylus bar—the principle of sound production is the same, resulting in perfect reproduction

O'Neil Mfg. Co.

714 Palisade Avenue **West New York, N. J.**

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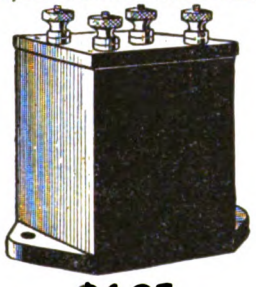
Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

A. J. HAYNES
Assoc. Institute of Radio Engineers
Designer of the Haynes Circuit described by Mr. Cockaday as the ideal tuning element of the super-heterodyne.

Haynes-Griffin Transformer



$4.25

A new air-core radio frequency transformer, sharply tuned to 3,000 meters. Upon the use of this transformer depends much of the success of the super-heterodyne model described. Haynes-Griffin Input Transformer also $4.25.

Haynes-Griffin Condenser .00023 mfd	$3.50
Haynes-Griffin Bank Wound Coupler	4.35
Haynes-Griffin Oscillator Coupler	2.75
F & K .0002 Microtune Vernier Condenser	5.80
Fada Socket	1.00
.5 mfd. fixed Condenser	.90
.0005 fixed Condenser	.35
.00025 mfd. fixed Condenser with Leak mounting	.45
¾ Meg. Leak	.50
.005 fixed Condenser	.60
Haynes-Griffin 20 ohm Rheostat	.85

The above list covers only certain of the most essential and special apparatus required by those building one or all of the units described. Send coupon for complete list of absolutely everything needed, including drilled panels.

The Haynes Circuit and the Super-Heterodyne

We have on hand a supply of reprints of the three articles by Laurence M. Cockaday on the Haynes Circuit, exactly as published in the September page (222) October (page 288) and November page (392) issues of POPULAR RADIO. These will be mailed to interested experimenters upon receipt of a 2c stamp for each article desired.

SEPTEMBER

In this first article (published in the September issue of *Popular Radio*), Mr. Cockaday describes how to make the Haynes Circuit—the finest one-tube receiver that can be built. Combines wonderful selectivity and extreme long distance range with a simplicity of construction never before equalled. 1,000 miles for $15.00

OCTOBER

In the October article, Mr. Cockaday explains the first addition that the ambitious experimenter can make to his original Haynes Circuit. He describes the Haynes two-stage audio frequency amplifier, which converts the Haynes Circuit to a three-tube receiver, permitting the use of a Loud Speaker.

NOVEMBER

The November article is regarded by many as the most important contribution to radio in the last year.
Mr. Cockaday describes the construction of a separate oscillator—the first step necessary to the construction of a simplified super-heterodyne circuit, using the Haynes Circuit as the tuning element.

Why you should read these articles

The beginner in radio will find in the September article on the Haynes Circuit itself a conclusive answer to all his radio problems. Mr. Cockaday shows how, at a maximum expense of $15, the average man can obtain a selectivity, long distance range, and volume of clear reception heretofore impossible at a cost of many times this amount.

As the series of articles progresses, the user of the Haynes Circuit will find that the development and possible additions to the Haynes Circuit more than keeps pace with his own growing interest and experience; until finally we have the super-heterodyne circuit itself—the ultimate of all radio receiving circuits.

Careful Preparation in Advance

enables us to render an unusually exact and prompt service to radio experimenters. Because many of the remarkable results described by Mr. Cockaday are directly dependent upon the use of new and differently designed material, we are prepared to furnish the identical apparatus recommended by him, without changes or substitutions of any kind. Much of this material was originally designed by A. J. Haynes and cannot be obtained elsewhere.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River

New York's Largest Radio Store

Haynes-Griffin,
41 West 43rd Street,
New York City.

Send me at once complete data and prices on all material mentioned by Mr. Cockaday in the four articles on the Haynes Circuit and Super-Heterodyne. I would also like to have a reprint of the articles in the issue of *Popular Radio* as checked:

September ☐ October ☐
November ☐ December ☐

.....

.....

HAYNES-GRIFFIN RADIO SERVICE, Inc.
41 West 43rd Street, New York City

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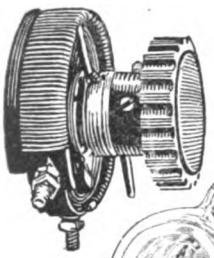
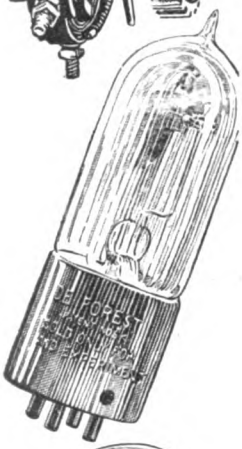
Three Things To Remember When You "Build Your Own"





THE success of that Radio Receiver you are going to build depends on just three things—the circuit, your care, and the parts you use.

Select your circuit—do a careful job—and use De Forest parts.

You protect yourself on the first two points—and the De Forest name protects you on the quality of the parts you use.

Remember that De Forest invented the 3-electrode vacuum tube that makes all present day radio possible. So you will naturally want to use De Forest wet or dry cell audions. Remember that the De Forest experience in building radio parts goes back a quarter of a century—no wonder you can rely on them. Condensers, variometers, tube sockets, potentiometers, grid leaks, switches, honeycomb coils, and coil mountings—let them all be De Forest—and you will get the results.

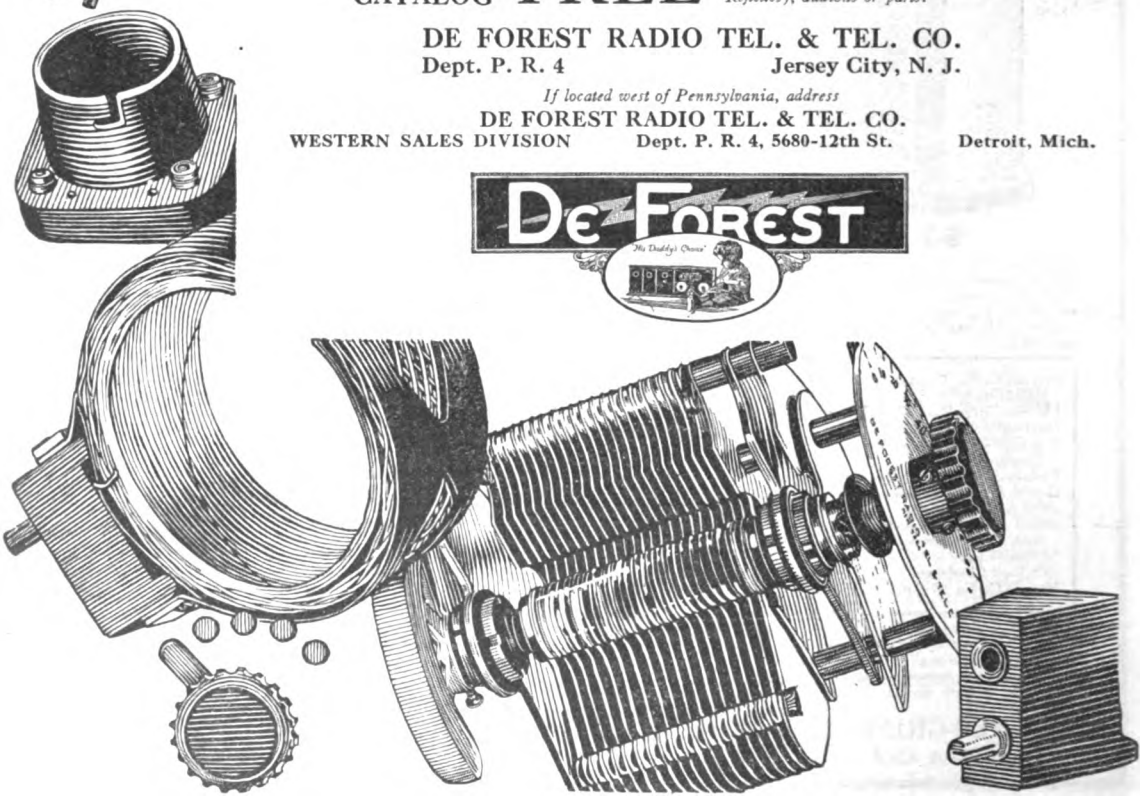
Or, if you want a short cut to radio enjoyment and listening in on the broadcast of the Continent—if you want to forget the outdoor antenna—if you want ease of operation and brilliantly clear reception without interference—buy a De Forest Reflex Radiophone.

Either way, you rely on De Forest, the greatest name in radio.

RADIO CATALOG **FREE** *Send for De Forest new radio catalog with description and prices on sets (including Reflexes), audions or parts.*

DE FOREST RADIO TEL. & TEL. CO.
Dept. P. R. 4 **Jersey City, N. J.**

If located west of Pennsylvania, address
DE FOREST RADIO TEL. & TEL. CO.
WESTERN SALES DIVISION **Dept. P. R. 4, 5680-12th St.** **Detroit, Mich.**



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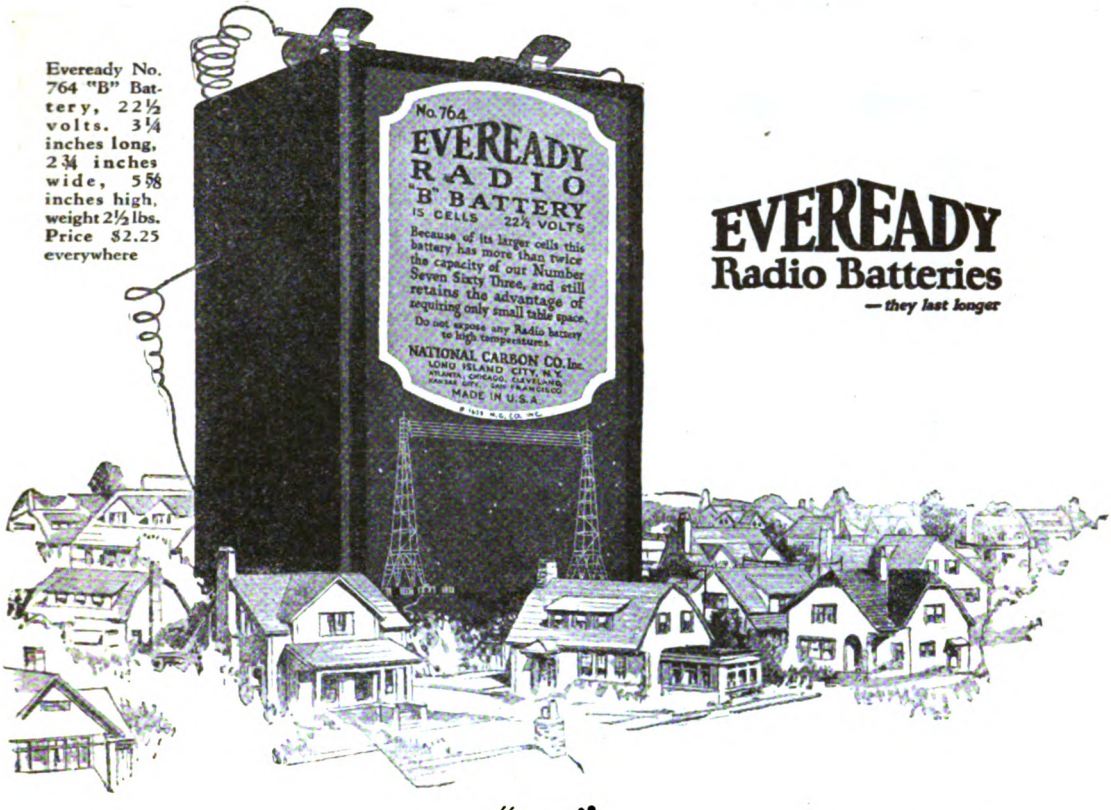
No. 764
EVEREADY
RADIO
"B" BATTERY
15 CELLS 22½ VOLTS
Because of its larger cells this battery has more than twice the capacity of our Number Seven Sixty Three, and still retains the advantage of requiring only small table space.
Do not expose any Radio battery to high temperatures.
NATIONAL CARBON CO. Inc.
LONG ISLAND CITY, N.Y.
MADE IN U.S.A.

Eveready No. 764 "B" Battery, 22½ volts. 3¼ inches long, 2¾ inches wide, 5⅝ inches high, weight 2½ lbs. Price $2.25 everywhere

EVEREADY
Radio Batteries
—they last longer

The skyscraper "B" Battery is here!

New—this upright Eveready "B" Battery for cabinet or table where space is limited

Here is a new "B" Battery that stands on practically the same size base as the smallest Eveready "B" Battery, but towers above it in height and capacity.

It is twice as high, and will last you more than twice as long.

And you pay only 50 cents more for the added capacity.

For portable sets, where smallest size and light weight are essential, the familiar favorite Eveready No. 763 is supreme at $1.75. But where weight is not so important as space, buy the more than double service of the *new* upright No. 764 at $2.25.

Fifteen vigorous cells give 22½ volts. Two Fahnestock Spring Clip terminals.

For compact capacity, buy the *new* Eveready No. 764.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, Inc., New York, N. Y.

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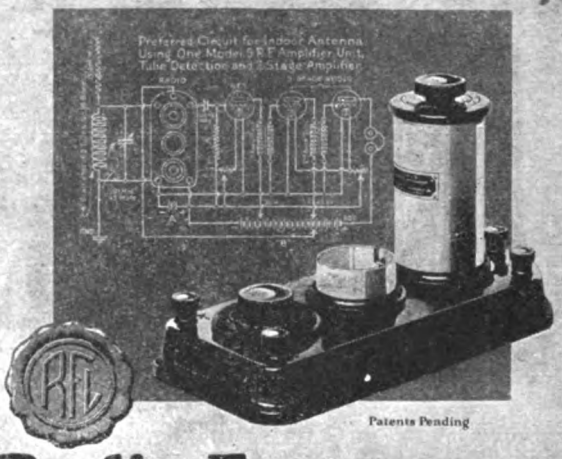
Turn the knob
Select the station you want to hear on indoor antenna or loop



Radio Frequency Amplifier Unit
with BALLANTINE Variotransformer
Fits Your Set

Add one or more stages of R. F. amplification to your present set—be it home-built or manufactured. Complete, with socket, rheostat and variotransformer, $15.00, at dealers, or postpaid.

Limited edition of "Radio Frequency Amplification with the Ballantine Variotransformers"—a 25-page booklet—mailed free on request.

BOONTON RUBBER MFG. CO.
Pioneers in making Radio parts of Bakelite
324 Fanny Road
Boonton, N. J., U.S.A.

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Careful Selection of Parts *Insures* Satisfaction!

OF COURSE the set you build is to be better than any owned by friends—and it can be. Avoid their mistakes—profit by experience—and build a set to be proud of. The difference in cost between a makeshift assembly and a good one is nominal—but the difference in reception results obtained is tremendous. For best results

Gilfillan Radio Parts

(*Units of Recognized Quality*)

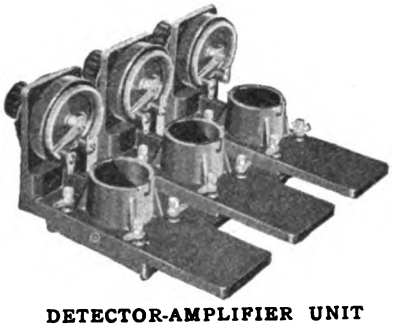
offer the most at least cost. Ask your dealer for these ***better*** parts. If your dealer does not handle *Gilfillan*, write us for name of nearest dealer, descriptive folder and list.

Genuine Gilfillan Radio Parts can always be identified by this trade-mark. Look for it.

See These New Units at Gilfillan Dealers

RADIO FREQUENCY VARIO-COUPLER

Sharp tuning and extreme selectivity are made possible by this unit. Highly recommended for radio frequency work. Local broadcasting easily tuned out in favor of more distant stations.



DETECTOR-AMPLIFIER UNIT

Admirably adaptable for radio frequency circuits or audio frequency work. Simplicity of wiring and exceptionally short leads. Jacks can be mounted directly to bottom, and transformers on platforms provided. Filament rheostats, tube sockets, binding posts and solder lugs complete in this unit.

OTHER GILFILLAN PARTS

Varicouplers (2 sizes)	Audio Frequency Transformers	Tube Sockets	Vernier Air Condensers
Variometers (2 sizes)	Primary Inductance Switches	Tube Socket Adapters	Filament Rheostats
Air Condensers (3 sizes)	Panel Switches	Detector Amplifier Units	Vernier Rheostats
Potentiometers		Detector Units	Moulded Knobs, etc.

GILFILLAN BROS. INC.

1925 McGee St., Kansas City, Mo. | **1815 W. 16th St., Los Angeles, Cal.** | **225 W. 57th St., New York, N. Y.**

Licensees General Bakelite Co.

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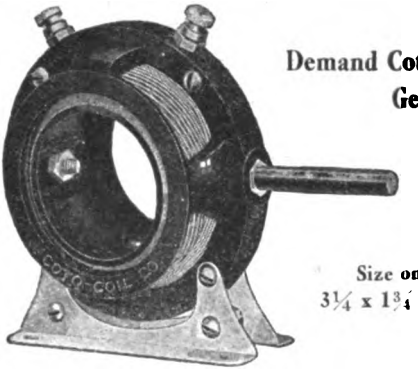
Coto

"Built First to Last"

Build Your Radio Set Coto Compact and Portable

Thousands upon thousands of radio listeners have learned the past summer that the static scare is a bugaboo. They listened in and enjoyed radio nearly every summer night.

Build your set now for portability. Make it an all the year set with Coto compact parts.



Demand Coto!

Get Coto!

Size only
3¼ x 1¾ x 3¾

New Coto Compact Moulded Bakelite Variometer

Notice the Honeycomb wound stator. By this means a range of 200 to 600 meters is obtained in unusually small space Here is a Variometer positive in action. Pigtail connection to rotor prevents clicking contacts. Mounts either on panel or base. Once you handle it you will take it home. Type 8000..... **$5.00**

Jobbers! Dealers!

The radio parts business is the foundation of your success. Coto offers you salability and reliability. Write for descriptions and prices.

Coto Coil Co.

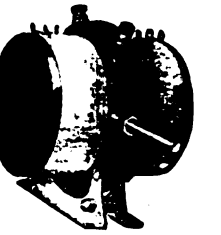
87 Willard Avenue

Providence, Rhode Island

Pacific Coast Branch,
329 Union League Bldg.,
Los Angeles, Cal.

Northwestern Branch
Geo. F. Darling,
705 Plymouth Bldg.,
Minneapolis, Minn

Southeastern Branch,
C. P. Atkinson,
Atlanta Trust Co. Bldg.,
Atlanta, Ga.

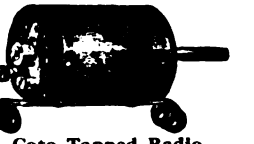


New Coto Compact Moulded Variocoupler

Companion piece of the Variometer. Size only 3¼ x 3 x 3¾ inches. Range 200 to 600 meters. Base or panel mount. Type 9000..... **$5.50**

The Original Honeycomb Wound Coils

Popular low-priced favorites of the amateur and experimenter. Maintained at a standard of excellence second to none. Sold mounted or unmounted.



Coto Tapped Radio Frequency Transformer

Efficiently covers the whole broadcasting range because it is TAPPED. Just turn the switch. Type 5000... **$7.50**

Coto Compact Air Condenser with Vernier

Only 2⅞ inches square. Rotor plates soldered to shaft. Stator plates soldered at three points. .0005 Mfd. $5. .001 Mfd. $6.

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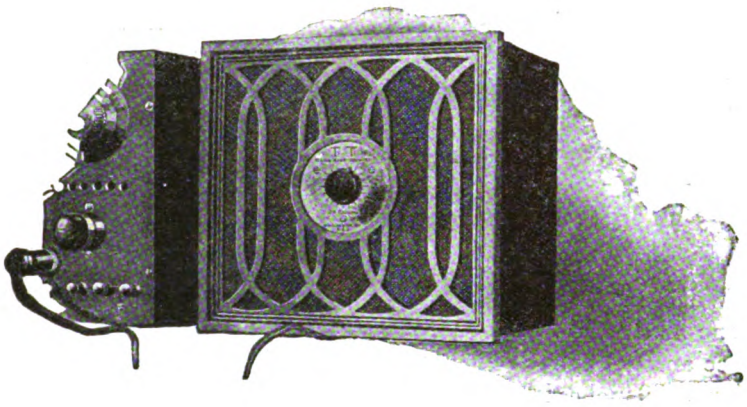


Its two horns Give volume—*without noise*

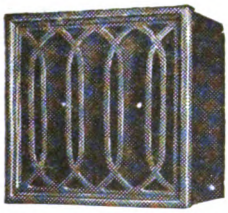
and without forcing your tubes

These horns in Timmons Talkers are so arranged that the tones, after being amplified in the small horn are re-amplified by being thrown against the especially prepared surface of the larger horn. The surfacing of the large amplifying horn is "acousticoat", a substance developed in the Timmons laboratories.

"Acousticoat" deadens all false tones and distortions and at the same time thousands of small craters in its surface pick-up even the most minute musical note and reproduce it clear, round and full.

But hear Timmons Talkers at your dealer's. Note also what fine pieces of furniture they are, with their screens and rich, hand-rubbed mahogany finish and their graceful Gothic grills.

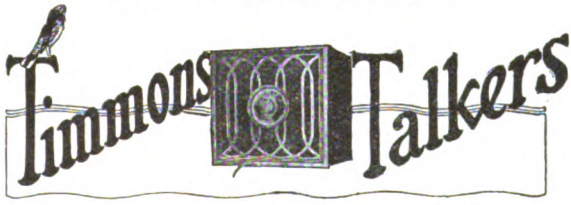
Also, your dealer will give you "Volume Without Noise" our new folder, or write us



The screen of type A (Adjustable) is rich bronzed gold. Type N (Non-adjustable) has a screen of copper-color mercerized Madras.

J.S.TIMMONS

339 East Tulpehocken St.
Germantown, Phila., Pa.
Manufacturer of Radio and Loud Speaking Telephone Apparatus



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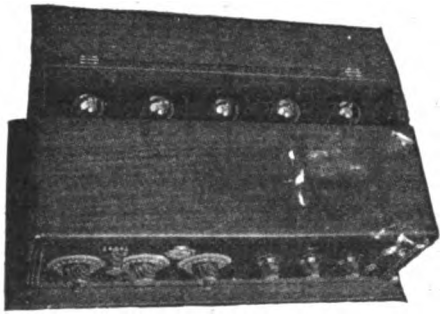
Tame the Wild Waves

with a *Service* Type 212 Receiver. Will tune through local phone and telegraph interference and get the distant stations. 30 inches loop antenna furnished with set.

***Price* $150.00**



Why take our word for what "Service" will do. Ask your dealer.

This is a *Teleforce* product

Dealers-Jobbers: Write for Terms and complete information

SERVICE ABOVE ALL

SERVICE RADIO CO.

4745 Montgomery Ave.
Norwood, O.

Every Question ANSWERED for only $1

At last you have under one cover a Complete Radio Handbook

JUST OUT
514 PAGES

Compiled by
HARRY F. DART, B.S.E.E.

Formerly with the Western Electric Co., and U. S. Army Instructor of Radio.

***Technically Edited by* F. H. DOANE**

NO more need you turn from book to book, hoping to find what you want. It is all here, in 514 pages crammed full of every possible radio detail. Written in plain language, by engineers for laymen. Clears up the mysteries, tells you what you want to know. A complete index puts everything within your reach in a few seconds.

IT EXPLAINS: Electrical terms and circuits, antennas, batteries, generators and motors, electron (vacuum) tubes, every receiving hook-up, radio and audio frequency amplification, broadcast and commercial transmitters and receivers, super-regeneration, codes, license rules. Many other features.

Under one cover. Yes, it is all in one volume of 514 pages of clear type with hundreds of diagrams and illustrations. Takes the place of eleven or more specialized texts, each costing from two to ten times the dollar you pay for this single book. Belongs in every radio-equipped home, on every amateur's table.

Send $1 to-day and get this 514-page I.C.S. Radio Handbook—the biggest value in radio to-day. Money back if not satisfied.

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I enclose One Dollar. Please send me—postpaid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

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Boys' Influence on Radio Buying Is Decisive

The growth of the radio business has been sudden, tremendous, and nation-wide. The demand for radio equipment has increased 60,000% in two years. To-day there are more than two and a half million radio sets in this country. And the radio business confidently anticipates even greater growth in the immediate future.

What has happened, and what will happen in radio, is directly attributable to the irresistible enthusiasm and contagious interest of boys. An overwhelming majority of radio sales are made to boys, to parents buying for boys, and to parents guided by boys. Right now, boys are recognized authorities on radio construction, installation and operation.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

goes to five hundred thousand creators of the radio business. Over half a million dyed-in-the-wool radio fans, averaging 15½ to 16 years old, read it regularly from cover to cover. THE AMERICAN BOY hits them right when their radio interest is all-consuming; when their spending money is considerable, and when their knowledge of radio holds the respect and interest of their elders.

Their own buying power, already large, is ever increasing. Their influence on buying is decisive. The radio manufacturer who is winning their interest and enthusiasm for his product, by advertising to them in their own magazine, is feeling the results in increased sales in every corner of the country.

Copy reaching us by December 15th will catch the February issue.

THE SPRAGUE PUBLISHING COMPANY
(Member A.B.C.)
548 Lafayette Boulevard, Detroit, Michigan

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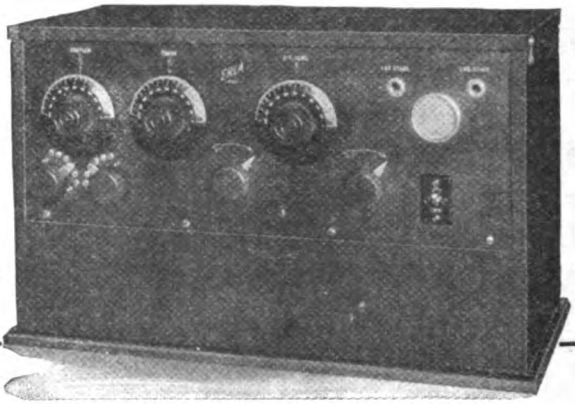
Build This Transcontinental Receiver At Half the Usual Cost!



Ordinarily You Would Pay From $125.00 to $250.00

This Way You Pay Only $65.00

So simple and inexpensive to build is the Erla transcontinental Triplex receiver that every home can now enjoy the infinite pleasure and variety of nation-wide loud speaker reception.

Erla parts, complete even to the cabinet and panel, and Erla solderless connectors, make child's play of the work of assembly. Accurate, easily understood drawings guide every step.

Materials are reduced to a minimum through the employment of Erla synchronizing transformers, enabling vacuum tubes to do triple duty. Only three tubes are used, yet costliest multi-stage amplifiers are surpassed in range and volume.

Choice of broadcasting programs is exercised at will, so sharp and selective is the tuning. Yet controls are so few and simple as to be operated by any child. Especially remarkable is the purity and fidelity of reproduction, exceeding the finest phonograph.

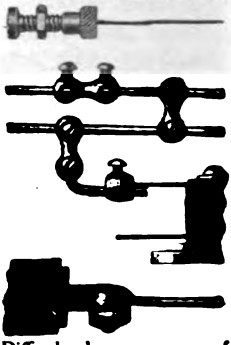
For further information regarding Erla Triplex, as well as perfected Erla one and two-tube receivers, consult Erla Bulletin No. 14, obtainable gratis from leading radio dealers. Or write us direct, giving your dealer's name.

Erla synchronizing radio frequency reflex transformers provide unequaled magnification without distortion. Types, reflex 1, 2. List, $5

Providing utmost sensitiveness with perfect stability, the Erla fixed crystal rectifier is uniquely adapted for reflex work. List, $1

Dealers and Jobbers—No day passes that Erla does not increase your opportunities for sales and profits. Write for sample Erla Triplex receiving sets, in beautifully finished solid mahogany cabinets, at manufacturers cost, for demonstration to your trade

The unique ability of Erla synchronizing audio transformers to reflex properly enables vacuum tubes to do triple duty. List $5



Difficult, dangerous use of soldering irons is eliminated by Erla solderless connectors, saving time, temper and money. List, 5c ea.

Electrical Research Laboratories

Dept R 2515 Michigan Avenue, Chicago

ERLA

The Copper Giant "A" Battery

For WD11, WD12 and other low voltage tubes. Equal to 20 dry cells. Can stand idle for years without deterioration and requires no attention whatever. Can be furnished mounted in radio cabinets. Write for circular.

THE COPPER GIANT BATTERY CO., Lansdowne, Pa.

FOR EFFICIENCY USE

FRAMINGHAM

DE LUXE PARTS

Ask Your Dealer

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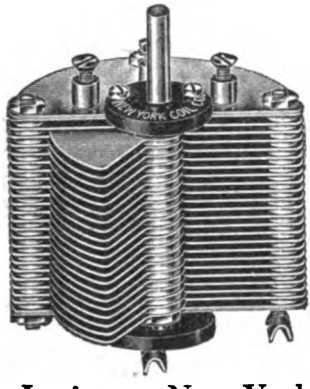
Are leaders everywhere due to quality, ease of installing and assurance that your set will bring in the results when finished. Used by leading constructors and handled by the best informed dealers.

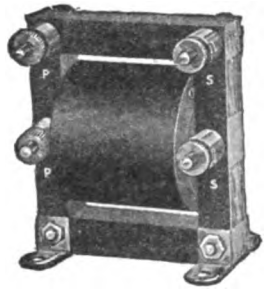


New York Condensers bring in the broadcasting loud and clear, with the true tone, because the construction eliminates **all leakage** and **electrical losses**—the standard by which others are judged.

11	Plate	**$1.50**
23	"	**2.00**
43	"	**3.00**
3	"	**1.25**

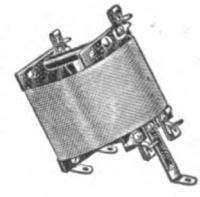
Supplementary Vernier Condenser $1.00

Insist on New York Amplifying Transformers. Do not be satisfied with something claimed to be "just as good." They are universally recognized for their marvelous **amplification,** purity of tone and ability to produce uniformly perfect results with any style of standard tube. Price $4.00 and worth it.



Our skeleton type tuned Radio Frequency Transformers really give the D X results with loop or indoor aerial that you have long wished for. Totally unlike any other in design or results. Two required, fully guaranteed.

$4.00 Each



Get literature on *Variometers, Couplers, Mica Condensers, Inductance Tap Switches.*

NEW YORK COIL CO., 338 Pearl St., N. Y. CITY

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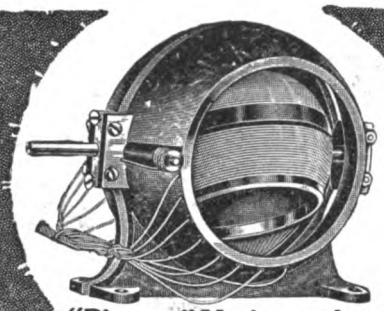


"Pioneer" Variocoupler

$7.00

"PIONEER"

Beauty is Only Skin Deep?

—not always

Might just as well build a good looking set as not.

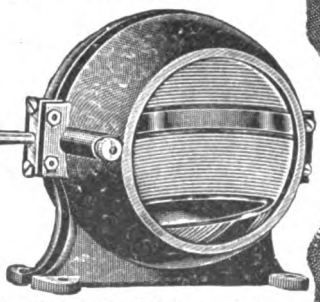
Build your set with Pioneer Variometers and Variocouplers and you have a set whose instruments are not only the most efficient yet devised but that for sheer beauty have nothing to equal them.

Pioneer Variometers and Variocouplers are made of genuine Bakelite, moulded in our own factory. A rich deep mahogany finish—the wiring is covered with pure green silk. The hardware is heavily nickeled. It will stand up. All contacts are positive—both instruments are made for either table or panel mounting.

Ask your dealer or write us.

"Pioneer" Variometer

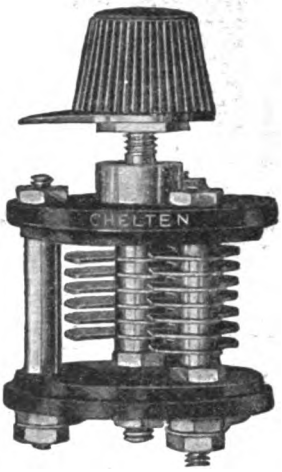
$6.50



Sales Agents in All Large Cities

PIONEER RADIO CORPORATION

100 Pioneer Ave., GALESBURG, ILL.



Price $1.50

Actual Size of the Midget Condenser
Patents Pending

This is the Low Capacity CHELTEN MIDGET variable condenser for Vernier regulation

OTHER NEW TYPE CHELTEN CONDENSERS ARE

MICROFARAD JR.
CHELTEN VERNET
RADIOSCOPE
CHELTEN SPECIAL

(*For Radio Frequency Circuits*)

Distributing Jobber's Catalogue for 1923-1924 now ready

Amateur's Catalogue mailed on request

CHELTEN ELECTRIC CO.

PHILADELPHIA

Eastern Sales Agents

H. N. SHEBLE CO.
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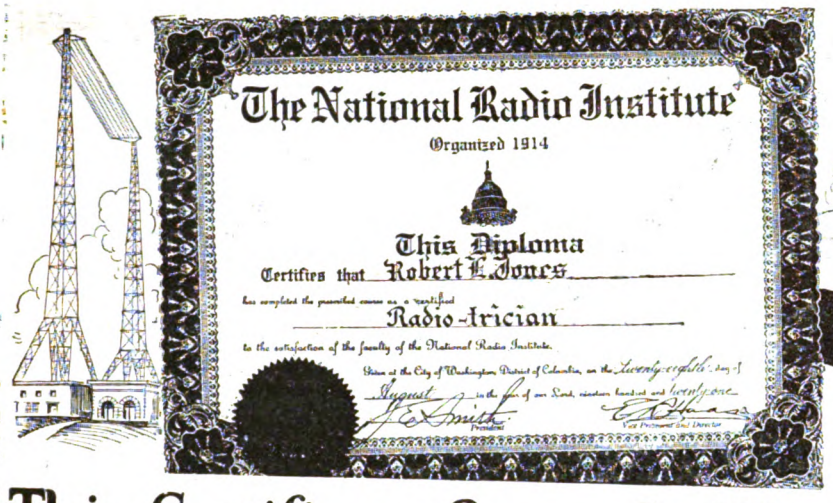
The National Radio Institute
Organized 1914
This Diploma
Certifies that Robert L. Jones
has completed the prescribed course as a certified
Radio-trician
to the satisfaction of the faculty of the National Radio Institute.
Given at the City of Washington, District of Columbia, on the
August

This Certificate Opens the Way to the Best Radio Positions

Get It—You Can Earn Big Money With It

No previous experience in electricity or Radio is necessary. In a short time, you can easily win this certificate and qualify for one of the splendid, big money positions in Radio.

Edwin L. Powell is an Expert Radio Aide at the Washington Navy Yard and earns **Big Money.** Leo Goldblatt is earning a Big Salary and all expenses paid as a radio operator. James F. Nicholls is earning $150 a month and all expenses as a radio instructor at Walter Reed Government Hospital. Harry Ruck has made **big money** manufacturing radio sets. Hundreds of other men are occupying equally attractive positions after winning our Certified Radio-trician certificate.

Read in the panel of the fine salaries paid in all the wonderful radio positions for which you can qualify once you have this certificate.

Pick Out the Job You Want And We Will Help You Get It

This is a brief list of the positions in the Radio field today, and the salaries paid.

Radio Mechanic, $1,500 to $4,000 a year.
Radio Inspector, $1,800 to $4,500 a year.
Radio Auditor, $1,200 to $1,800 a year.
Radio Salesman, $2,000 to $10,000 a year
Radio Engineers, $3,500 a year and up.
Radio Executive, up to $15,000 a year.
Radio Aide, $6 to $10 a day.
Radio Draftsman, $7 to $15 a day.
First Grade Ship Operator, $105 a month, all expenses paid.
Second Grade Ship Operator, $95 a month, all expenses paid.
Third Grade Operator, $85 a month, all expenses paid.
Commercial Land Station Operator, $150 a month and up.
Broadcasting Station Operator, $125 to $250 a month.

Easy Now to Become A Certified Radio-trician

No other work in the world today offers such opportunities, such big money, such rapid advancement, such a promising future as does Radio. And the Expert Radio-trician is the man who is in a position to choose the best of these opportunities—to jump farthest ahead in this newest and fastest growing industry.

Become an Expert Radio-trician. You can—easily and quickly. The National Radio Institute, America's first and largest Radio School, has devised a remarkable method that makes it easy for anyone to qualify right at home during spare time. Prominent radio experts give you personal advice and instruction through the mail. They grade your papers, answer your questions, and in every possible way help you in your work. And you learn the practical, wonderful side of radio by actual practice on patented instruments we send you free. The Certified Radio-trician Certificate awarded you on the completion of your course **is government recognized, counting for 5 to 10 points on all government license examinations.**

Instruments Loaned to Students

An extraordinary feature of this course is the use of four patented instruments, owned exclusively by us, which give practical training in radio operation, installation, maintenance and repair—all of which you **must** have to become an Expert Radio-trician.

Among these instruments is the wonderful Natrometer, said by experts to be the perfect device for teaching the Radio Code. All of these instruments are loaned to students.

Send for Radio Book

Thousands of positions are open to Certified Radio-tricians. Find out what **your** opportunities are in this fascinating profession. Send for interesting book, "Your Opportunity in Radio," which gives complete details on plan by which the National Radio Insitute quickly qualifies you at home in spare time as a Certified Radio-trician. Send the coupon or a postcard for free book. **NATIONAL RADIO INSTITUTE, Dept. 32-M, Washington, D. C.**

Radio Operator

Radio Mechanic

Radio Salesman

Radio Engineer

NATIONAL RADIO INSTITUTE, Dept. 32-M, Washington, D. C.

Send me your book, "Your Opportunity in Radio," with full particulars about the opportunities in radio, and how you will quickly train me in my spare time at home to win a Certified Radio-trician Certificate. Also about your employment service.

Name.....Age.....

Street.....

City.....State.....

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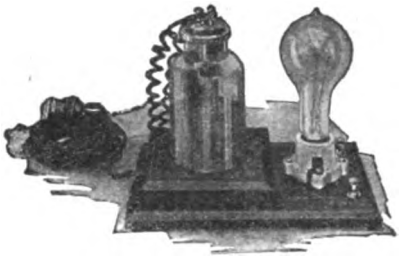

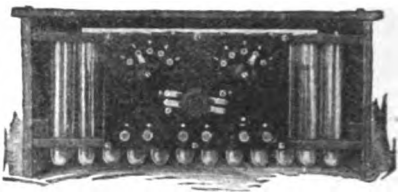

Trinidad government pleased with KICO efficiency—

"We are ordering this battery on behalf of the Trinidad Government whose wireless officer was impressed with the efficiency of the Kico battery we are using with our receiving set." The above extract is only one of the many endorsements we are receiving of Kico Batteries. Alkaline type, won't sulphate or buckle. Life unlimited. Not harmed by short circuiting, overcharging, idleness. Panel switches give single cell variation. Recharge from any 110-volt A.C. line with small home rectifier. Charge lasts 3 to 6 months in detector plate circuit.

KIMLEY ELECTRIC COMPANY, Inc.
2667 Main Street **Buffalo, N. Y.**

KICO **Storage "B" Batteries—long service, low cost**

GUARANTEE

Your money back on any KICO Battery if not satisfied within 30 days' trial. Write for full information on "A" and "B" Batteries.

Unmounted Rectifier $1.00
Mounted Rectifier $2.50

Cells	Volts	Price, Plain	With Panels
16	22	$5.50	
24	32	7.25	$11.75
36	48	9.50	14.00
50	68	12.50	17.00
78	100	17.50	22.50
108	145	23.50	28.50

An Ideal Christmas Present for the Radio Family

Build yourself a high grade receiving set—*at a big saving!*

No soldering of joints, no tools necessary. Simple connections made to binding posts. Each RPM instrument is of the highest grade and complete in itself with all wiring concealed and properly insulated to stand exposure. Bakelite mounted—handsome in appearance. *Hook-up circuits in every package.*

Every unit you need to assemble a high grade receiving set at low cost is included in the RPM Line; mounted and unmounted; variometers, variocouplers, variable condensers, coupled circuit tuners. Detector and amplifying units—each the best you can buy, yet surprisingly low in price.

This is the No. 201 RPM mounted Coupled Circuit Tuner. Bakelite panel. $12

RPM

ADD-A-UNIT LINE

RADIO PRODUCTS MFG. CO.
667 W. 14th St. Chicago

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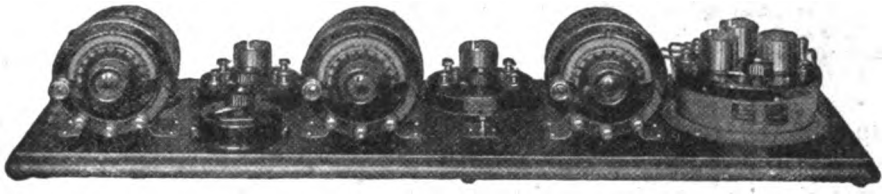
ATWATER KENT

RADIO EQUIPMENT



The Atwater Kent Model 10 Receiving Set

THIS Receiving Set is the latest achievement of the ATWATER KENT Research Laboratories. With it you will enjoy many surprises due to its remarkable performances in radio reception.

Unusual volume and clearness of tones are easily obtained from distant points. Despite its wide range, this instrument is exceedingly simple to operate.

When the dial positions have once been noted on the Model 10 Receiving Set, the operator can tune in the desired broadcasting station at will.

ATWATER KENT Equipment embraces a variety sufficiently wide to meet the requirements of every user of radio:—it includes complete sets and every instrument necessary for the assembling of sets from tuning unit to loud speaker.

Literature describing the entire line of Atwater Kent Radio Sets and Parts sent on request

ATWATER KENT MANUFACTURING COMPANY
4933 STENTON AVENUE, PHILADELPHIA, PA.

Makers of
THE WORLD'S HIGHEST GRADE IGNITION
STARTING AND LIGHTING

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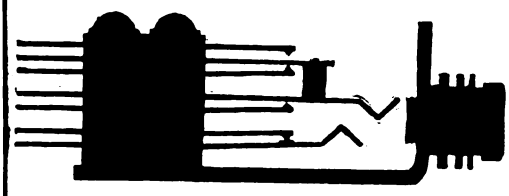
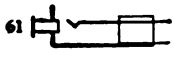
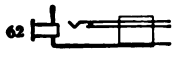


There's a Pacent Quality Jack for Every Circuit

Right in every detail of their construction, Pacent Jacks can be depended upon to function properly at all times, and to give long satisfactory service.

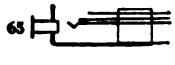
The complete line, including a number of Jacks not ordinarily available, is illustrated below.

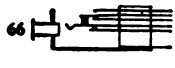

No. 61—Single Open Circuit Jack Price, 60c


No. 62—Single Closed Circuit Jack Price, 70c

No. 63—Double Circuit Jack Price, 80c

No. 64—Heavy Duty (Loop) Jack Price, $1.00


No. 65—Three Spring Automatic Jack Price, 85c


No. 66—Five Spring Automatic Jack Price, $1.00

No. 67—Seven Spring Automatic Jack Price, $1.00

No. 68—Four Spring Automatic Triple Circuit Jack Price, $1.00

No. 69—Five Spring Special Automatic Jack Price, $1.00

No. 70—Six Spring Automatic Jack Price, $1.00

Write for new Illustrated Catalog (P-12) of Pacent Radio Essentials

Pacent Electric Co., Inc.
22 Park Place, New York

Sales Offices: Philadelphia, Washington, Minneapolis, Chicago, St. Louis, San Francisco, Jacksonville

Pacent
RADIO ESSENTIALS

Morrison

Loud Speaker

If You Are Critical

Ask the man who is proud of his receiving set—who boasts of the wonderful reproduction from long distance stations—ask him what Loud Speaker he uses and he will say "Morrison." Today people want to hear their opera and their dance orchestra in clear, full tones entirely free of harsh noises.

Attach Morrison Loud Speaker to the tone arm of your

PHONOGRAPH

or use it with your

HORN

and you will be proud to entertain your friends with a real radio concert. Tones adjusted soft or loud by a turn of a little dial —no other adjustment necessary.

Sold under an absolute money-back guarantee. Order from your dealer or send direct to factory.

$10.00

Nickle Plated Model
Complete with 5 foot cord

$15.00

Gold Plated Model

Illustrated Catalog will be sent free on request.

DEALERS

Morrison Loud Speaker is Radio's most popular merchandising unit. We have a plan to help you sell that many of the best dealers in the country are finding quite profitable. Wire us today.

MORRISON LABORATORIES, Inc.
345 Jefferson Ave., East; Detroit, Mich.

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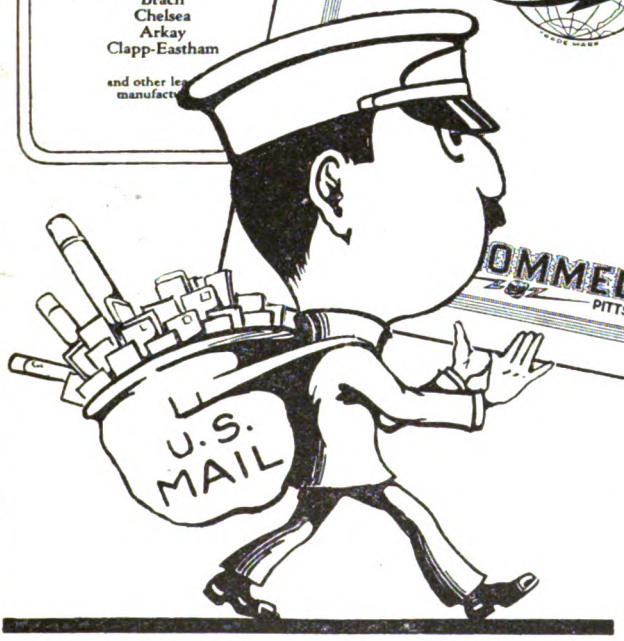

Send for it
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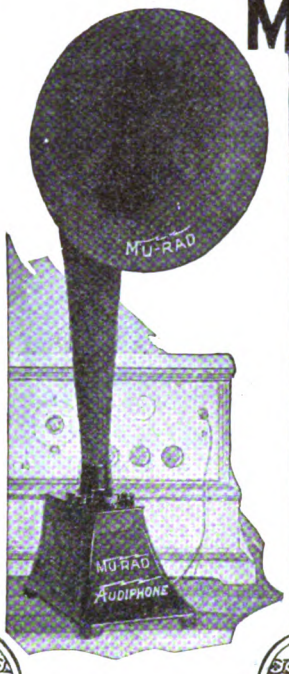
The MU-RAD AUDIPHONE



WITH one daring stroke of genius, the MU-RAD AUDIPHONE transcends all previous conceptions of radio sound amplification. Modelled upon the principles of the human vocal organ. The super-sensitive mica diaphragm is actuated by an armature which expands and contracts just like the larynx in the throat. Hence, the MU-RAD AUDIPHONE responds in perfect harmony to all voice and music vibration ranges. Extremely fine, easily operated, exterior adjustment of diaphragm eliminates distortion.

No Extra Battery Connections-PRICE $25

WRITE FOR BOOKLET AND NAME OF THE NEAREST MU-RAD DEALER!

MU-RAD LABORATORIES, INC.

809 FIFTH AVE ASBURY PARK, NEW JERSEY

Radio Frequency Unit $3.50

The UNITED

Radio Frequency Transformer $2.50

Radio Frequency Unit

The New United Radio Frequency Unit

Type RU-1 has nothing to equal it in efficiency, design and amplification.

The very latest design in Radio frequency Amplifier —reduces capacity effect to a minimum—short leads (not necessary to be longer than 1"). Units can be placed close together when two or more stages are used. Handsomely finished in black and polished nickel—2¼" square.

United Radio Frequency Transformer

200–600 meters. It has an air core and impregnated windings. Can be used for table panel or socket mounting. It has a highly polished nickel finish—with black ends. Gives excellent results with any standard radio frequency, Reflex, Inverse Duplex or Neutrodyne Circuits.

United Audio Frequency Transformer

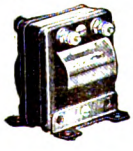
Made in 2 ratio: A1—5 to 1; A2—3.5 to 1. Finished in Black with Nickel trim. For one, two or more stages of Audio Frequency Amplification.

United Condensers—Both Vernier and Plain

Have become the Standard Condensers through their unequalled performance in all circuits.

Write for complete catalog of United Quality Radio Products, tells how to make a power amplifier out of an audio Transformer.

Audio Frequency Transformer $4.50



United Mfg. & Distributing Co.

9704 Cottage Grove Ave., Chicago, Ill.

N. Y. Office: 50 Church St., New York, N. Y.

San Francisco Office: 709 Mission St., San Francisco, Cal.

Condenser Vernier and Plain— $2.25 to $6.50

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Travel Across the Country Most Any Night With the

ACE $20 TYPE V

Formerly called Crosley Model V

Armstrong Regenerative Receiver

Licensed under Armstrong U. S. Patent No. 1,113,149

The Ace Type V Armstrong Regenerative Radio Receiver is without doubt the most popular of all sets. Its low cost is not indicative of its efficient service because it performs equally as well as any one tube at any price.

The very first evening you enjoy the Ace Type V you'll wonder how you ever did without it.

Under ordinary conditions you can pick up stations from coast to coast one after the other, with this long range regenerative receiver. A loud speaker can be operated in connection with the Ace Type V by simply adding an Ace Type 2B, a new two-step Audio Frequency Amplifier, which sells for $20.00. This makes it possible to hear a concert all over the house.

This set is so low in cost that everyone can now afford to enjoy radio. Don't be without radio entertainment any longer—listen to the world's best talent—both instrumental and vocal.

Prices do not include batteries, tubes or head phones. Buy these from your dealer.

If your dealer cannot supply you, order direct, mentioning his name. Ask for "Simplicity of Radio." Your copy is FREE.

DEALERS: Write on your letterhead for attractive sales proposition.

"List price west of the Rockies 10% higher. In Canada tariff added." Be sure to come to the Grand Annual Radio Exposition, Coliseum, Chicago. Visit our booth on the Collonade, November 20 to 25th.

The Precision Equipment Company

Powel Crosley, Jr., President

1216 Vandalia Avenue, Cincinnati, Ohio

Ace Type 3C Consolette

This is a new addition to the Ace Family. Has beautiful solid mahogany, wax finished cabinet. Set consists of a regenerative tuner, detector and two stages of Amplification, with built in loud speaker. The tuning circuit is licensed under the Armstrong U. S. Patent No. 1,113,149 and due to the particular method of winding Crosley coils it is exceptionally selective. Has sufficient room inside Cabinet for dry batteries making a complete self contained long range receiving outfit. Phone jack for tuning with head phones; Crosley multistat; filament switch Crosley moulded condenser; beautifully engraved Formica panel. Uses all kinds of tubes. A wonderful set at a remarkable price, $125.00—without tubes or batteries.

The New Ace Type 3B

This set is equal to a combination of the Ace Type V and the Ace two-stage amplier. Manufactured under Armstrong U. S. Patent No. 1,113,149. A filament switch eliminates necessity of turning out rheostats when set is not in use. You may turn off the set by throwing switch and come back later without retuning. Has telephone jack in between first and second stage. Crosley Multistats. Universal filament control rheostats for all makes of tubes. Price $50.00.

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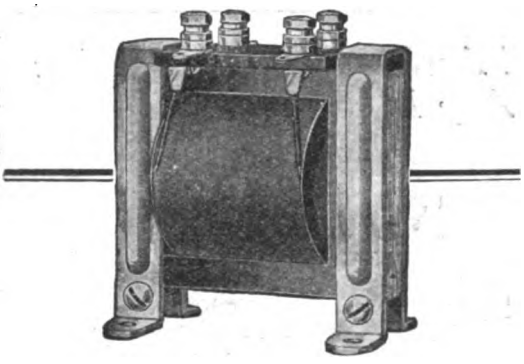


GENUINE

JEFFERSONS

The Standard Audio Frequency Transformers

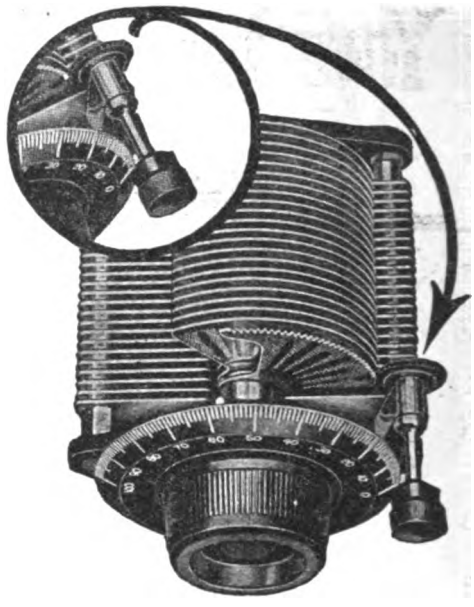
No matter what circuit you wish to complete, there is a JEFFERSON Audio Frequency Amplifier which will insure 100% Amplification, the elimination of distortion and the quiet easy tuning so eagerly sought after.

FIVE JEFFERSON TYPES

to choose from—manufactured by the pioneers in the audio frequency transformer field. Right from the start put Jeffersons in your set—don't experiment—expert Radio Engineers, after careful and exhaustive tests have found them perfect in every detail of construction.

DESCRIPTIVE BULLETIN sent free and our Engineering Department will be glad to make recommendations as to the proper transformer to be used in any circuit

Jefferson Electric Mfg. Co.
427 S. Green Street **Chicago**



Heath's Radiant Condensers

Heath Radiant Condensers will tune as perfectly years later as they do the day you install them. The plates, (which in other condensers buckle and get out of alignment) in **Radiant Condensers** are made **permanently** FLAT by a patented process. They are pressed into **absolute** flatness and then tempered, so that they can **never lose that flatness!** Look for the Radiant trade-mark, impressed on every rotary plate of Heath's Radiant Condensers.

Vernier, Geared Like a Watch
Adjusting knob geared to vernier plate so that an ordinary turn is reduced to micrometer fineness. Positive, accurate, durable. No play. Separate tension adjustment.

Write for illustrated booklet and name of the nearest Radiant Dealer.

PRICES
Vernier Type

13 Plate including 2¼" dial and knob	**$5.00**
25 Plate including 2⅛" dial and knob	**5.50**
43 Plate including 2⅛" dial and knob	**6.50**

Jobbers and Dealers Write Immediately for Proposition

HEATH RADIO & Electric Mfg. Co.

204 First Street
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Your Kellogg Radio Christmas

Here is a way to get a wonderful receiver of Kellogg parts that most radio fans will tell you, are the most reliable, durable and efficient on the market. In several million families this year, each of us will be racking our brains to think of some Xmas present to please each member of the family.

Forget all this trouble and work, and plan a radio Christmas. Ask the boy or dad to make up a list of reliable parts for a simple set; then each one buy one part for someone in the family, and you will have a receiving set that will bring Christmas carols, and the world to your fireside, if you have efficient Kellogg parts carefully put together.

Such assembling is an easy matter with Kellogg radio equipment. There are thousands of circuits, some very efficient, both as to distance and selectivity, that require only a condenser, coupler [or variometer], tube socket, fixed condenser, grid leak, tube, dials, and a few other inexpensive parts. You don't need to buy an expensive cabinet to have a good radio set.

If your dealer does not handle Kellogg, send us his address. We will send you our helpful and valuable radio hand book. Start today on your Christmas receiving set, and make every member of the household happy.

KELLOGG SWITCHBOARD & SUPPLY COMPANY

CHICAGO, ILLINOIS

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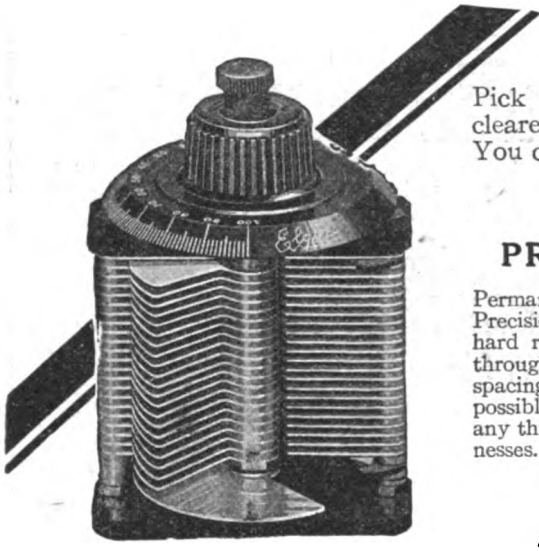

for Better Receiving

Pick up those distant stations louder and clearer. Eliminate noise and interference. You can do this when you use

Elgin
PRECISION CONDENSERS

Permanent accuracy and rigidity are built into Elgin Precision Condensers. Plates are made of specially hard rolled aluminum and are of uniform thickness throughout. Special process spacers assure uniform spacing of plates. Adjustable vernier shaft makes it possible to use the Elgin Vernier Type Condenser on any thickness of panel and with dials of different thicknesses.

Size	Capacity	Plain	Vernier
3 Plate	.000063 M. F.	$1.75	$——
11 Plate	.00025 M. F.	2.40	4.00
17 Plate	.00035 M. F.	2.75	——
23 Plate	.0005 M. F.	3.00	4.50
43 Plate	.001 M. F.	4.00	5.50

3" diameter composition dials, 50c extra

FULLY GUARANTEED

See your local dealer. If he cannot supply you send his name with your order to

The Elgin Tool Works
Incorporated
69 N. State St.
ELGIN, ILL.

New-
CONTROL-O-METER

You don't have to be annoyed any longer by a jumble of words and music from two broadcasting stations when you want to hear *one* of them. Through the development of the Control-O-Meter, the simplest set is made as selective as the most complicated and yet the addition of this instrument will not increase the difficulty of tuning. All you have to do is to connect your antenna to one convenient binding post of the Control-O-Meter and your set to another, then turn the Control-O-Meter dial until the interfering station disappears—and the only way you *can* bring the station back is to change the Control-O-Meter setting.

To assist you in quickly setting the Control-O-Meter, each instrument is individually calibrated in our laboratory and a chart provided showing the setting for each wave length.

The Control-O-Meter, with its piano finished mahogany cabinet, faced with a polished bakelite panel and handsome dial, matches the best of standard sets.

The Control-O-Meter is a perfected instrument that has made good in the most congested radio districts in the United States. *You* will get results the moment you turn the dial.

LIST PRICE $12.50 COMPLETE

If your dealer cannot supply you, a Control-O-Meter will be sent you direct, postpaid, upon receipt of the above amount.

MALONE-LEMMON PRODUCTS
Made by **STEPHENSON LABORATORIES**
342 MADISON AVENUE
NEW YORK CITY

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Sodion

A New Era in Radio

That, in the fullest sense of the word, is what the SODION TUBE means to everybody who owns or expects to own a receiving set.

Based on an entirely new principle—utilizing the highly valuable and peculiar properties of the sodium ion

The Sodion Tube

(Sodium-Ion)

is many times more sensitive and produces far stronger signals than any detector yet developed.

Due to the fact that it cannot be made to oscillate, it not only eliminates any semblance of whistles or beat-note howls in your own reception, ***but does not interfere with the reception of others.***

At a meeting of the Institute of Radio Engineers where this tube was being demonstrated, a prominent Scientist and Radio Engineer, in contrasting this with the action of the ordinary detector, dubbed it

"THE GOLDEN RULE TUBE"

Stable and uniform in operation. Runs for hours without adjustment. Has no grid. No grid leak or grid condenser are required. Crystal tone reception. Unusually sensitive to weak signals. Operates on dry cells or storage battery.

Bulletin A-100 describing this tube upon request.

CONNECTICUT TELEPHONE & ELECTRIC COMPANY
MERIDEN *RADIO DIVISION* **CONNECTICUT**

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BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

FAST SERVICE—WE PAY TRANSPORTATION CHARGES EAST OF THE ROCKIES

SUPERIOR VARIOMETER

A525 Each.....$4.45
Forms moulded of red brown bakelite. A neat handsome instrument. Green silk windings calculated for highest efficiency. ¼ inch shaft. Noiseless pigtail connections. Table or panel mounting. Produces superior results in any type circuit 180 to 650 meters.

SUPER 180° VARIOCOUPLER

A521 Each.....98c
A wonderful value, produces excellent results. Green windings on black fibre tubes. Rigid mounting support for table or panel mounting. Primary tapped for fine tuning. ¼ inch shaft. Range 200 to 600 meters.

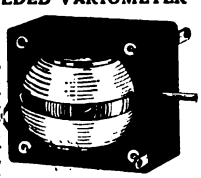
A522 Variometer—same style. Each.98c

SUPERIOR VARIOCOUPLER

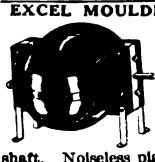
A523 Each.....$3.15
A handsome instrument of superior design and construction. Stator tube and rotor ball of moulded red brown bakelite. Large size green silk windings insure highest efficiency. Table or panel mounting. ¼ inch shaft. Superior results in circuits for 180 to 650 meters. Tapped primary for finest tuning. Noiseless contacts.
A526 Special single circuit type....$3.60

SUPER MOULDED VARIOMETER

A412 Each $2.70
Polished black moulded rotor and stator forms. Maximum inductance with greatest efficiency and minimum distributed capacity. A high grade instrument that will get the best results. Wave length 180 to 600 meters.



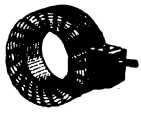
EXCEL MOULDED VARIOMETER



A524 Each...$3.60
A wonderful value at our price. Properly designed and constructed. Polished black bakelite rotor and stator forms. Large size green silk wire insures greatest efficiency. ¼ inch shaft. Noiseless pigtail connection. Table or panel mounting.

This Guarantee Protects You.
Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

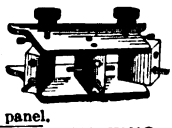
RADIO INDUCTANCE COILS



Carefully made—fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm impregnation. Range given is in meters when used with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art No.	Not Mntd.	Art No.	Price Mntd.
25	120- 250	A301	$0.39	A320	$0.85
35	175- 450	A302	.42	A322	.95
50	240- 720	A303	.49	A323	1.02
75	390- 910	A304	.54	A324	1.08
100	500- 1450	A305	.58	A325	1.13
150	600- 2000	A306	.63	A326	1.17
200	900- 2500	A307	.72	A327	1.26
250	1200- 3500	A308	.78	A328	1.35
300	1500- 4500	A309	.82	A329	1.36
400	2000- 5000	A310	.97	A330	1.57
500	2800- 6100	A311	1.12	A331	1.63
600	4000-10000	A312	1.27	A332	1.78
750	5000-12000	A313	1.43	A333	1.93
1000	7900-15000	A314	1.70	A334	2.25
1250	9750-19500	A315	1.92	A335	2.45
1500	14500-26500	A316	2.18	A336	2.60

INDUCTANCE COIL MOUNTINGS



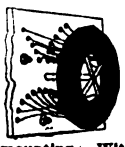
A340—3 Coil. Ea.....$3.40
A341—2 Coil. Ea.....2.75
Sturdy, rigid durable construction. Made of polished black bakelite. Mount on front of panel.

BACK OF PANEL MOUNTING
Mounts back of panel, with knobs or dials on front of panel. Helps make a neat efficient set.
A342—3 coil Back of Panel Mounting.....$4.45

COIL MOUNTING PLUGS

Made of genuine bakelite.
A344 Plug for mounting "honeycomb" inductance coils.....39c
A345 Stationary plug to fasten mounted coil stationary to panel.....42c
A346 Movable plug to fasten mounted coil to panel so it can be rotated.....89c
A343 Fibre strip to hold coils for mounting. Two foot piece.....15c

REINARTZ INDUCTANCE



A296 Each.....$1.15
Made of green silk covered wire, spider-web wound to produce greatest efficiency and lowest losses. 21 taps so arranged that crossing is avoided. Two fibre strips and wooden rod furnished permit various styles of mounting. With this coil a high grade set can be built at low cost. Diagram included.

SPIDER WEB COILS
A290— 25 turn.39c **A292**—50 turn.47c
A291— 35 turn.42c **A293**—75 turn.54c
A294—100 turn. Each.....58c
A new popular type of inductance of highest efficiency. Lowest distributed capacity and lowest high frequency resistance. Firm green silk windings with fibre mounting strips.

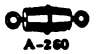
ULTRA AUDION COIL
A296 Each.....85c
Spider web wound of green silk covered wire. Four taps. Produces wonderful results. Fibre strips and wooden rod for mounting included. Diagram included.

STRANDED ANTENNA WIRE
Cable of fine copper strands. Very flexible. High tensile strength. Best for aerials.
A248—100 ft. coil 58c. **A249**—500 ft. coil $2.75

SOLID BARE COPPER WIRE
Solid bare copper wire for aerials, leads or wiring instruments.
Solid Bare Copper Wire, size 14.
A240—100 ft. coil 48c. **A242**—500 ft. coil $2.25
Solid Bare Copper Wire, size 12.
A244—100 ft. coil 67c **A245**—500 ft. coil $3.05

BRASS ROD
Supplied only in 8 inch lengths.
A961 Threaded 6-32, per 8 in. length..6c
A963 Threaded 8-32, per 8 in. length..8c
A965 Solid 3-16 in., per 8 in. length..6c
A967 Solid ¼ in., per 8 in. length....9c

ANTENNA INSULATORS



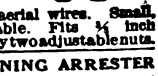
A-260

A260 Size 1x3½. Composition, metal eyelets. Two for.....17c
A264 Size 1½x4. For medium size aerials. Two for.....69c

A264-6

A266 Size 1½x10½. For large aerials. Two for.$1.28
A263 Ribbed Porcelain Insulator. 2½ in. long. Each 6c Dozen.....55c

LEAD-IN INSULATORS



A270 For 4 inch walls or less Ea. 42c
A271 For 9 inch walls or less. Ea. 69c
The only practical lead-in insulator for aerial wires. Small, neat, effective, durable. Fits ¼ inch hole. Securely locked by two adjustable nuts.

OUTDOOR LIGHTNING ARRESTER

A980 Price.....$1.55
Protect your instruments with this lightning arrester. Weatherproof porcelain case. Air gap type. Permanent. Durable. Underwriters approved.

High-Grade Lightning Arrester

A981 Each.....79c
A dependable protector, always on guard. Small and compact. Weatherproof porcelain case. Easily fastened and connected. Underwriters approved.

DETECTOR PARTS

A725 Price set..27c
All metal parts for crystal detector. No base included. Easily assembled. Polished nickel finish.

OUR SPECIAL VARIOMETER AND VARIOCOUPLER

Build into your set reliable instruments. You can depend on this variometer and variocoupler to give you the best results in any circuit working from 180 to 650 meters. In design and construction they are the best. Only the highest grade materials are used. The prices quoted save you 30 to 40 per cent. Why pay more?

A418 Variocoupler. Each.....$2.45
The most efficient type of coupler, insures better tuning and louder signals. Primary and secondary wound on natural uncolored genuine bakelite tubes. Handsome green silk windings. Primary tapped for fine tuning. Can be panel or table mounted. ¼ inch shaft.
A410 Variometer. Each.....$2.10
Perfect in design and construction. Accurate wood forms thoroughly seasoned. Correct inductive ratios. Solid baked windings. Plenty of large sized wire insures highest efficiency. A strong high grade instrument that will give you lasting service. ¼ inch shaft.

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

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USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

"CONSOLIDATED" RADIO PLAN PACKETS

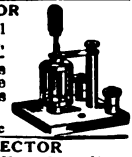
Designed and laid out by the foremost radio engineers. With their help you can build an outfit that will give the finest results. Every packet contains complete instruction for the construction and tells what tools and parts are needed. Detailed directions for drilling, mounting and wiring, also how to handle set after it is built. Thousands of sets have been built from these plans and are in perfect operation. Folder giving detailed description of each packet sent on request.

Price per packet.....42c

Order item wanted by article number.

A640 How to make a Neutrodyne Receiver.
A641 How to make a Reinartz Receiver.
A642 How to make a Regenerative Receiver.
A643 How to make a Cockaday Receiver.
A644 How to make a Reflex Receiver.
A645 How to make Detector and Amplifier Units.
A646 All about aerials and their construction.
A647 Twenty Radio Diagrams of Latest Hook-ups.
A648 14 Radio Formulas and Diagrams.

ENCLOSED DETECTOR



One of the finest crystal detectors on the market, supersensitive galena crystal enclosed in heavy glass shield. Quick, positive adjustment. Brass parts polished nickel finish.

A730 Each.....89c

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and knob. Brass parts polished nickel finish. An unequaled value.

A732 Each.....59c

DETECTOR CRYSTAL CAREFULLY TESTED

A736 Galena, Arlington tested, piece.19c
A738 Silicon, Arlington tested, piece 19c
A735 Tested, Galena, mounted, piece. 9c
A737 Tested, Silicon, per piece.....9c
A739 Genuine million point crystal Ea.21c

BAKELITE DIALS

A931—2 in. Diam. for 3-16 in. shaft. Each..35c
A932—2 in. Diam. for ¼ in. shaft. Each....35c
A933—3 in. Diam. for 3-16 in. shaft. Each..39c
A934—3 in. Diam. for ¼ in. shaft. Each....39c
A935—4 in. Diam. for ¼ in. shaft. Ea..41c

Moulded in one piece of genuine bakelite in polished black finish. Finely engraved scale in contrasting white enamel. Sure grip knob that fits the fingers. Higher grade dials for good sets. Sizes match perfectly.

THREE INCH DIAL

A923 For 3-16 inch shaft. Each.....19c
A924 For ¼ inch shaft. Each.....19c

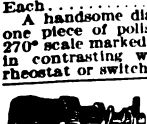
A handsome neat looking dial moulded in one piece of polished black composition. 180° scale marked 0 to 100 finely engraved in contrasting white enamel. Diameter 3 inches.

TWO INCH DIAL

A921 For 3-16 inch shaft. Each.....16c
A922 For ¼ inch shaft. Each.....16c

A handsome dial moulded in one piece of polished black composition, 270° scale marked 0 to 100 finely engraved in contrasting white enamel. Fine for rheostat or switch control. Diam. 2 in.

VERNIER DIAL ADJUSTER



A941 Each.....19c

Easily installed at edge of dial, gives finest vernier adjustment of condenser or inductance. A great value. Polished black knob.

Over 30,000 Barawik Radio Sets Are Operated All Over the World

All of these sets were built with Barawik Standard Radio Parts mostly by persons without any previous radio experience. These home-made sets equal in results the best factory made sets—many are even superior and at a cost only a fraction of the cost of the factory made sets. You can easily equal these results by following directions given in the numerous magazine articles on radio. Also directly below you will find listed Blue Prints, Instruction Packs and Books. With the help of these anyone can successfully make a Radio Set.

RADIO BOOKS

That every Home Builder and Amateur needs. Written in plain simple language everyone can understand.

A631 100 Radio Hookups. Each...25c

Shows hookups from the simple crystal set to the more elaborate and latest tube circuits. Numerous types of Reflex, super-Regenerative, super-Heterodyne, Neutrodyne, Reinartz, Flewelling, Bishop, etc.

A632 How to Tune your Radio Set. Each.....25c
A633 How to Build Loud Talkers. Each.....25c
A634 How to Make Radio-Phone Receiving Sets. Each.....25c
A635 How to Make Radio Frequency Amplifiers. Each.....25c

STANDARD TUBE SOCKET

A140 Each.....39c

Moulded of genuine red brown bakelite. Binding post connections. For table or panel mounting. Neat and strong.

METAL TUBE SOCKET

A146 Each.....39c

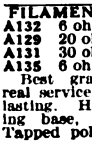
A strong durable socket for panel or table mounting Metal tube and base. Plainly marked binding post connections well insulated.

TWO AND THREE GANG SOCKETS

These sockets make it easy to build detector and amplifier units and make a neat, compact workmanlike job. Perfectly made of highgrade materials. Quickly mounted on panel or base.

A147 Two-gang socket.....95c
A149 Three-gang socket.....1.30

199 SOCKET



A145 Each.....49c

Moulded of high insulating material. Sponge rubber base prevents ringing in tube. Plainly marked binding post connections. Neat and compact.

FILAMENT CONTROL RHEOSTATS

A132 6 ohm. Each....45c
A129 20 ohm. Each .52c
A131 30 ohm. Each .52c
A135 6 ohm Vernier..95c

Best grade. Will give real service. Durable and lasting. High heat resisting base, diam. 2¾ in. Tapped polished black knob 1¾" diam.

Potentiometers. Match above rheostats. Same high grade construction.

A151 200 ohm. Each.....79c
A152 400 ohm. Each.....79c

SUPERIOR RHEOSTATS

A153— 6 ohm. Each.....69c
A154—20 ohm. Each.....76c
A155—30 ohm. Each.....83c

The finest rheostat. Smooth, even action. Best design, best workmanship. Supplied with attractive dial and knob. A rheostat for high grade sets.

Potentiometers to match above rheostats with dial and knob.

A156—375 ohm.....98c

QUICK ACTING RHEOSTAT

A124— 6 ohm. Ea..79c
A125—15 ohm. Ea...88c
A126—30 ohm. Ea...99c

Vernier adjustment at every degree of resistance Pushing knob in turns off the filament.

PRINTS OF POPULAR CIRCUITS

These prints give a full-size panel layout, schematic hookup, hookup showing parts wired and explanatory notes. With them as a guide anyone can build a set that will operate perfectly and bring in the long distance stations.

A621 One Tube Reflex and Amplifier. Each.....10c
A622 Single Circuit Tuner. Each..10c
A623 Reinartz Tuner using Spider Web Coil. Each.....10c
A624 Radio and Audio Frequency Amplifier Each.....10c
A625 Short Wave Regenerative Set, using two Variocouplers. Each....10c
A626 Honeycomb Coil Circuit and Amplifier. Each.....10c

VACUUM TUBES

Standard Brands—Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

A 106 Detector UV200
A 500. Each.....$4.38
A 112 Amplifier, UV201A
A 501A.....5.85
A 118 5 Watt Transmitter 7.70
A 107 WD11 C11. Each 5.85
A 101 WD12 C12. Each 5.85
A 102 UV199 C299. Each.....5.85
A 104 UV199 Adapter fits 199 tube to standard socket.....42
A 108 WD11 Socket. Each.....31
A 109 WD11 Adapter. Each.....45

SUPERIOR VARIABLE GRID RESISTANCE

A167 Each.....80c
A166 With .00025 Condenser.....95c

Eliminates hissing, clarifies signals. Capacity smoothly varied from 0 to 6 megohms by half turn of knob. Easily mounted on any panel.

A171 Panel mounting variable grid leak with .00025 condenser.....Each 69c
A172 Variable grid leak with mounting. Each.....89c
A173 Variable grid leak. Each....$1.19

TUBULAR GRID LEAKS AND CONDENSERS

Very convenient Permit of quick change of leaks, or condensers of varying capacity. Cut shows leak mounted. Leaks and condensers have same appearance. Each part priced separately.

A849 Grid Leaks. Each.....18c

Resistances—½, 1, 1½, 2, 3, 5, 7, and 10 megohms. Specify which size is wanted.

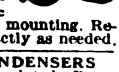
A831 Grid and Plate Condensers. Ea.39c

Capacities—.00025, .0001, .00025, .0005 mfd. Specify which size is wanted.

Mountings. Bakelite base.

A841 Single mounting. Each.....29c
A842. Double mounting. Each.....49c
A844. Triple mounting. Each.....69c

VARIABLE GRID LEAKS



A160 Standard style..15c
A161 De Luxe style with extra heavy screw top, finely finished.....32c

Pencil mark type for panel mounting. Resistance may be varied exactly as needed.

GRID CONDENSERS

A162 Well insulated. Paper covering. Each.....8c
A163 Highest grade. Mica insulated. Polished nickel case. Each.....23c

Fit over posts of above leaks. The combination makes an efficient unit. Cap .00025 mfd.

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

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BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

FAST SERVICE—WE PAY TRANSPORTATION CHARGES EAST OF THE ROCKIES

SPECIAL PRICES ON ALL RADIO GOODS

If what you want is not quoted here, write for prices. We can save you money on any Radio set or parts. Our stock is complete, we can ship promptly almost every brand of headset, loud-speaker, tube, variometer, etc.

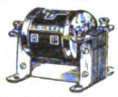
BARAWIK QUALITY HEADSETS

A770 Per Set, 2000 ohms.....$3.25

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are fine polished finish with polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices than we ask, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

A550 Each.....$2.25



The result of years of research work and experienced engineering. In quality of tone and volume of sound, the things a transformer is built for, we guarantee it to equal or surpass any other transformer. Neat in appearance. Carefully made. Fully mounted with plainly marked binding post connections. 5 to 1 Ratio. Wonderful results on one, two or three steps without distortion or howling. A quality item in every respect. Not to be compared with articles built for price only.

RADIO FREQUENCY AMPLIFYING TRANSFORMER

A560 For 201A or 301A Tubes.....$1.70

A561 For 199 or 11 or 12 Tubes.....$1.70

Due to its special design this transformer will produce wonderful results in any type of regular or reflex radio frequency circuit. While low in price we believe it equal or superior to higher priced transformers. Perfect for one, two or three stages. Compact, convenient form, easily mounted. Range 175 to 600 meters. Try it. If you are not satisfied return it and get your money back.

TINNED COPPER "BUS BAR" WIRE

Size 14 tinned copper wire. For wiring sets. Best size for neat job and easy soldering.

A957 Round. Ten feet for.....12c

A958 Square. Ten feet for.....14c

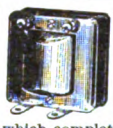
SPAGHETTI

For covering connecting wires in sets. For size 12 and 14 wires.

A955 Finest quality braided and saturated with best baked lustrous transparent insulating varnish, 3 feet for.....19c

A956 Best quality braid and covered with black insulating compound. 3 feet for..9c

OUR SPECIAL SHIELDED TRANSFORMER



A551—3½ to 1 Ratio Each.....$2.55

A552—6 to 1 Ratio. Each.....$2.75

The same high grade style of transformer as above enclosed in a metal case which completely shields it from any outside magnetic influences. Very attractive appearance and sturdy construction. Free from howling and local disturbances.

NEUTRODYNE TRANSFORMERS

A571 Per set of three.....$4.95

An air core transformer for use in neutrodyne method of reception. Can also be used for tuned radio frequency or as a fixed coupler with condenser across secondary. Proper design for results and efficiency. Green silk windings on bakelite tubes with adjustable mounting brackets to fit most any condenser.

SPECIAL

A573 Neutrodyne Jack. Each.....69c

NEUTRALIZING CONDENSERS

A572 Per set of two.....40c

Simple, inexpensive, effective precision type. Micrometer adjustment is attainable. Easily mounted in circuit.

PORCELAIN BASE SWITCHES

Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

A385 Single Pole Single Throw. Each 20c

A383 Single Pole Double Throw. Each 32c

A384 Double Pole Double Throw. Each 50c

ENCLOSED VARIABLE CONDENSERS

One of the best made condensers. Rigid, accurately spaced aluminum plates. Formica ends. Engraved scale. Knob and pointer. Clear transparent case.

A806 43 plate .001 Mfd. $2.80

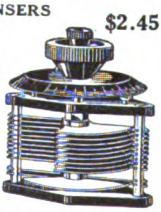
A808 21 plate .0005 Mfd .2.45

PANEL MOUNTING VARIABLE CONDENSERS

59c

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Fine polished end plates of heavy bakelite. Shafts ¼ inch diameter. Sturdy, heavy aluminum alloy plates perfectly spaced to insure smooth, even, reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with many inferior, cheap condensers offered. We guarantee them to please you or your money back. The vernier style has one separately controlled plate which permits of the finest tuning.

$2.45



REGULAR STYLE

A815— 3 plate.....59c

A816— 5 plate.....97c

A814—11 plate .00025 mfd.....$1.28

A813—21 plate .0005 mfd..... 1.35

A812—43 plate .001 mfd..... 1.58

VERNIER STYLE

Including Dial and Knobs

A825—14 plate .00025 mfd.....$2.45

A824—26 plate .0005 mfd..... 2.75

A826—46 plate .001 mfd..... 3.15

RADIO SOLDERING IRON

A540 Each.....$1.50

Soldered connections in radio sets produce better results. This guaranteed iron is exactly right for radio work. A neat solid connection quickly and easily made. Operates on any lighting socket 100 to 120 volts. 6ft. cord with attaching plug. Length 13 inches. Heats quickly, will not overheat.

Heavier irons for general repair or manufacturing work. Wonderful values at our prices.

A541 Medium size..$3.48

A542 Larger size..... 4.25

AUTOMATIC BLOW TORCH

A543 Each.....$1.19

Burns denatured alcohol. Automatically generates pointed flame in a few seconds. Easy to solder joints in hard places. Lights with a match. Burns 20 minutes on one filling. 5½ inches high, ⅞ inch diameter cylinders. Works fine with Tinol listed below.

TINOL

A969 Per tube 19c

A combined solder and flux in handy form. Put a little on the connection, heat with a match, torch or solder iron and you have a neat electrically and mechanically perfect joint.

SUPER BLOW TORCH

A544 Each.....39c

Burns denatured alcohol. Vest pocket size. Blowing on tube produces a hot pointed flame. Lights with a match. Works fast. Burns 10 minutes on one filling. Easy to solder joints in hard places. 3 in. high. ⅞ in. cylinder. Long rubber tube. Produces fine joints with Tinol listed above.

LONG NOSE PLIERS

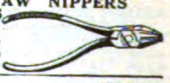
A970 Price...95c

The handiest pliers for radio work. Made of ne hardened steel Length, 5 in.

DIAGONAL JAW NIPPERS

A972 Price...$1.05

For fine electrical work, made of hardened steel, length 5 inches.



FOUR-IN-ONE Screw-Driver

A974 Each.....55c

Especially suitable for radio work. Will handle any size screw used. Smaller drivers nest inside larger one and are held in place with screw cap. Made of steel, nickel finished.

MAGNET WIRE

Insulated copper wire. Best quality even drawn wire, one piece to a spool. Prices quoted are for 8 oz. spools unless otherwise stated.

Double Cotton Covered		Enameled Insulation		Green Silk Covered	
No. A990		No. A992		No. A991	
Gauge	Price	Gauge	Price	Gauge	Price
18	43c	20	39c	20	$0.78
20	55c	22	50c	22	.95
22	70c	24	55c	24	1.10
24	80c	26	60c	26	1.38
26	90c	30	65c	30(4 oz.)	1.25
28	$1.05	32	70c	32(4 oz.)	1.65
30	1.45	36	90c	36 (4 oz.)	2.20

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

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USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

BINDING POSTS

Brass, polished nickel finish. Washer and 6-32 in. screw extending ¼ in.

A370 Large size—barrel and knob ¾" Mfg. Dozen.....85c

A372 Smaller size—barrel and knob 9-16" long. Dozen.....70c

A370-2-4 **A376-8**

A374 Large size with composition knob. Dozen.....45c

A376 Large size with hole for phone tip or wire. Dozen.....80c

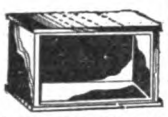
A378 Small size with hole for phone tip or wire. Dozen.....35c

RADIO "BAKELITE" PANELS

Notice our very low prices on this fine quality material. Others ask as much for hard rubber panels which are worth much less. We supply genuine Bakelite, Condensite Celeron or Formica, all of which are materials with practically identical mechanical, chemical and electrical properties. Machines well without chipping. Won't warp. Waterproof. Highest mechanical and dielectric strength. Attractive natural polished black finish which can be sanded and oiled.

Panel Size Inches	¼" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No	Price
6x 7	A450	$0.57	A460	$0.86	A470	$1.15
6x10½	A451	.86	A461	1.27	A471	1.73
7x14	A458	1.38	A468	2.07	A478	2.76
7x18	A453	1.78	A463	2.65	A473	3.56
7x21	A457	2.05	A467	3.05	A477	5.10
7x24	A459	2.42	A469	3.56		
9x14	A454	1.85	A464	2.65	A474	3.56
12x14	A455	2.42	A465	3.56	A475	4.78
12x21	A456	3.62	A466	5.35	A476	7.13

CABINETS



Fine looking cabinets solidly built. Elegant hand rubbed dark mahogany finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside High	Inside Wide	Dimensions Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	A420	$2.15
6x10½"	5½"	10"	7"	A422	2.65
7x10"	6½"	9½"	7"	A421	2.90
7x12"	6½"	11½"	7"	A424	3.05
7x14"	6½"	13½"	7"	A423	3.20
7x18"	6½"	17½"	7"	A426	3.45
7x21"	6½"	20½"	7"	A425	3.85
7x24"	6½"	23½"	7"	A429	4.65
9x14"	8½"	13½"	10"	A428	3.55
12x14"	11½"	13½"	10"	A430	4.65
12x21"	11½"	20½"	10"	A432	5.45

BEZELS

A641 Diameter ¾ inch—Each.....15c

A642 Diameter 1½ inch—Each.....15c

Polished nickel finish. Finest quality. Fit any thickness panel. Greatly improve appearance of panel.

RUBBER COMPOUND PANELS

Made of a special compound having a rubber base. Equal in appearance and in all essential points to any other class of panels. Fine smooth polished finish. Can be drilled or cut without chipping. Guaranteed not to warp and to be a perfect insulator for radio use. Smooth clean edges. Thickness 3/16 inch. Size given is in inches.

A481	7x10..	$ .88	A484	7x18..	$1.60
A482	7x12..	1.05	A485	7x21..	1.85
A483	7x14..	1.22	A486	7x24..	2.10

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

SUPERIOR RADIO JACKS

Finest Grade Jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in.

A390 Open circuit. Each.....38c

A391 Closed circuit. Each.....46c

A392 Two circuit. Each.....55c

A393 Single circuit filament control..59c

A394 Two circuit filament control...76c

COMPETITOR JACKS

A387 Open circuit. Each.....27c

A388 Two circuit. Each.....35c

Well made, durable, smooth working nickel finished frame. Well insulated.

SUPERIOR RADIO PLUGS

A395 With set screws for fastening cord. Each...35c

A397 Two-way—takes two pair any style cords. Each.....59c

Highest grade plugs. Fit any standard jacks. Polished round barrels.

SWITCH CONTACT POINTS

Brass polished nickel finish. All have ¼ in. long size 6-32 screws and two nuts. All prices the same.

Dozen 18c Hundred $1.05

Order by Article Number.

A360 Head, ¼" diam.; ¼" high

A362 Head, 3-16" diam.; ¼" high

A363 Head, 3-16" diam.; 1-16" high

Solder Lugs to Fit Contact Points

Also for connecting wires to binding posts, etc.

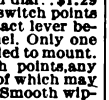
A365 Dozen 8c Hundred 30c

SWITCH LEVER STOP

Brass polished nickel finish.

A386 Dozen 18c Hundred $1.05

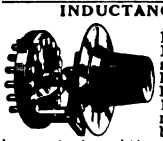
SWITCH LEVERS



Very neat polished black composition knob. Exposed metal parts polished nickel finish. Fitted with panel bushing and two set nuts. A high grade switch.

A381 1¼ in. Radius. Ea. 15c

INDUCTANCE SWITCH



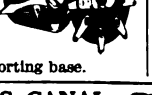
A285 Price including knob and dial..$1.25 Mounts switch points and contact lever behind panel. Only one hole needed to mount. 15 switch points, any number of which may be used. Smooth wiping contacts. Attractive tapered knob.

SILVERED METAL DIAL

A651 Each.....65c

Same as used on above switch. Polished black knob. Engraved graduations.

SUPERIOR INDUCTANCE SWITCH



A286 Each.....79c

Quickly and securely mounted by drilling one hole. Only knob and pointer show in front of panel. Connections can be soldered before fastening switch, making assembly much easier. Metal parts nickeled. Bakelite knob and supporting base.

PLATE CIRCUIT "B" BATTERIES

You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

A180 Signal Corps type, small size. 15 cells, 22½ volts. Each.....$1.10

A182 Large size, 5 taps 16½, 18, 19½, 21 and 22 volts. Each.....$1.59

A184 Variable Large Navy size, 16½x4x3 inches 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each..$1.95

A188 Combination Tapped 45 volts, 30 cell, 13x4x3 battery. Tapped to give 45, 22½, 21, 19½, 18 and 16½ volts. Handles both detector and amplifier tubes. Ea. $3.65

STORAGE "A" BATTERY

A very high grade battery made especially for radio service. Guaranteed for three years. Properly cared for will give many years of service for filament lighting. Made of best new materials. Full capacity. The best battery buy on the market. Try one of these batteries on your set for 10 days. If at the end of that time you are not fully satisfied with the battery return it and we will refund the purchase price.

A194 6 volt, 40 amp. size. Each.$10.75

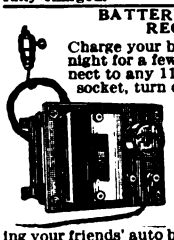
A196 6 volt, 80 amp. size. Each. 13.25

STORAGE "B" BATTERY

A790 Each.....$8.75

The most satisfactory and practical 24 volt storage B Battery. Rubber case carefully sealed to prevent leakage. Connections are brought out at every cell for voltage regulation in 2 volt steps. Shipped fully charged.

BATTERY CHARGING RECTIFIER



Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips.

A201 For 6 volt battery.....$12.95

A203 For 12 volt battery..... 12.95

HYDROMETER

A190 Each.....48c

Accurately tells you the condition of your storage battery. Helps you keep your battery in better condition.

BATTERY CLIPS

A198 Two for.....25c

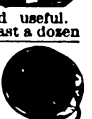
Clip onto storage battery terminals, lead coated. Make positive non-corrosive contact at all times.

WIRE CONNECTING CLIPS

A199 Per dozen.....30c

Small connecting clips for quickly fastening leads onto binding posts, etc. Handy and useful. Every radiolst should have at least a dozen

"B" BATTERY METER



A189 Each.....98c

Reads 0 to 50 volts. Accurately tells you the exact condition of your B Battery. Convenient watch size. Polished nickel case with wire lead.

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

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You Don't Need To Be An Expert

RADIODYNE

"The Voice of a Nation"

The RADIODYNE is operated by simply grounding to a water pipe or radiator and throwing a few feet of wire on the floor. No outside antenna or loops necessary. You don't have to be an expert to install and operate it effectively.

For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other types of receiving sets would not be practical.

Stations within a radius of 2000 miles can be picked up on the loud speaker; any wavelength from 200 to 700 meters. The RADIODYNE is so sensitive that it picks up Radio telephone speech and music when other types of equipment fail.

Write for illustrated folder which describes the RADIODYNE in detail. Every radio fan will be interested in this new type (antennaless) receiving set.

WESTERN COIL & ELECTRICAL CO.
308 Fifth St. Racine Wisconsin

DESIGNED ESPECIALLY FOR RADIO RECEIVING

We are Manufacturers of Fine Furniture and we sell direct to you with only a small factory profit.

A handsome hardwood hand-rubbed mahogany or golden oak finished Radio Table. Size of top 20 x 34 inches x 31 inches high.

Conceals A & B batteries. Small drawer holds tools and accessories.

PRICE, FREIGHT PAID, East of Mississippi River.....**$18.00**
FREIGHT PAID to Rocky Mt. States..**20.00**
FREIGHT PAID to Pacific States.....**22.50**

Cash with order. Prompt shipment.

CABINET PRICES REDUCED!

Hardwood, hand-rubbed mahogany finish. Hinged top.

Panel Size	Depth	Price
6 x 7 in.	7 in.	**$2.25**
6 x 10½ in.	7 in.	**2.50**
6 x 14 in.	7 in.	**3.00**
6 x 21 in.	10 in.	**3.75**
7 x 18 in.	10 in.	**3.50**
9 x 14 in.	10 in.	**3.50**
12 x 14 in.	10 in.	**4.00**

POSTPAID, East of Missisippi River.

POSTPAID to Rocky Mt. states, add 25 cents.

POSTPAID to Pacific states, add 50 cents.

Cash with order. Prompt shipment.

Send for free catalogue of Radio Furniture.

THE SOUTHERN TOY CO.
HICKORY, NORTH CAROLINA

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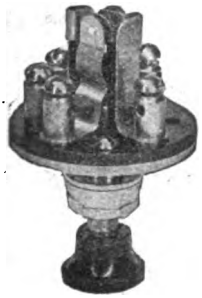
Inductance Switch
Price $1.50



Detector Amplifier Switch
Price $1.50

Single Pole Double Throw Switch
Price $1.25

Double Filament Control Jack
Price $1.25

JOSEPH W. JONES

One of America's leading inventors, and who has been granted over 300 patents.

Inventor of the method now used for making Disc Phonograph records.

Inventor of the pioneer Speedometer and the Best, The Jones.

Inventor of the Jones Victometer, or Aeroplane Tachometer, used by the U. S. Army and Navy.

Inventor of the Jones Motrola, which eliminates the need of phonograph winding

Inventor of the Jones Electric Drill.

JOS. W. JONES RADIO
TRADE MARK

Invented these

IMPROVED ANTI-CAPACITY

Radio Jacks and Switches
To Save Your Time and Money

HERE is a line of radio jacks and switches radically different in design and construction from any similar product. They are *not* telephone fittings modified for radio use, but are designed especially to meet the exacting requirements of the radio enthusiast who knows what he wants.

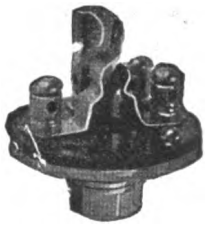
They save drilling and soldering—give you better results by eliminating capacity effects—give you a neater set, because they eliminate contact points on front of panel—they save your time, temper and money.

Most radio dealers have these little round jacks and switches with the red button. If yours hasn't, send us his name and ask for folder describing the entire line.

Grid Leak
Price $1.50

Double Circuit Jack
Price $1.00

Open Circuit
Price 70 cents



Single Filament Control Jack
Price $1.00

RADIO IMPROVEMENT CO., Inc., 25 W. 35th, New York

Agents in 26 Principal Cities

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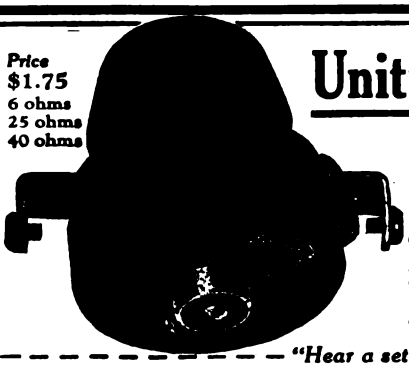


Price
$1.75
6 ohms
25 ohms
40 ohms

Unity Rheostats are the Best

Vernier and Non-Vernier

The Unity Vernier Rheostat

The highest type electrical instrument made for controlling resistance.

A refinement in tuning adjustment, far surpassing the possibilities of any other instrument, is very easily obtained.

The Unity Vernier Rheostat is the only Rheostat with a cut-out switch operating with no change in tuning adjustment.

— — — — — — — — — — *"Hear a set that uses Unity Rheostats"* — —

The Unity Non-Vernier Rheostat

or the Cartridge Rheostat

Where a non-vernier rheostat is sufficient, the Unity Cartridge Rheostat is the best made.

In addition, resistance cartridges are interchangeable without removing the bracket from the panel.

Unity Potentiometer Cartridges also fit the Unity Brackets

If your dealer cannot supply you, send your check or money-order to the factory with dealer's name.

UNITY MFG. CO., 228 North Halsted St., Chicago

Automatic Screw Machine Products, Stampings, General Manufacturing on Contract or Royalty.

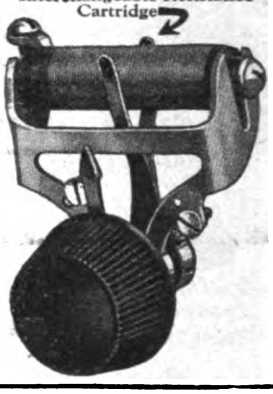
Dealers are offered a free Counter Display Card.

6 ohms
25 ohms
40 ohms

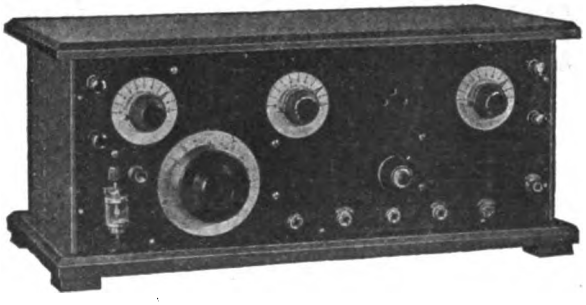
Other resistances if desired

Complete Rheostats - - $ .80
Brackets only .45
Cartridges, any resistance - - .35
Potentiometers, complete, 200 or 400 ohms 1.45
Potentiometer cartridges only 1.00

Interchangeable Resistance Cartridge



EACO DUPLEX RECEIVERS



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CLARITY
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A Revelation in Radio Frequency

A supersensitive Receiver incorporating two stages of Tuned Radio Frequency. Affords the user choice of either crystal or tube detector, with or without amplification. Ideal for use with loud speakers of any type. Delivers great volume from distant Broadcasters. Will operate without an aerial.

Literature and prices furnished upon request.

ECONOMIC APPLIANCE COMPANY, Irwin, Penna.

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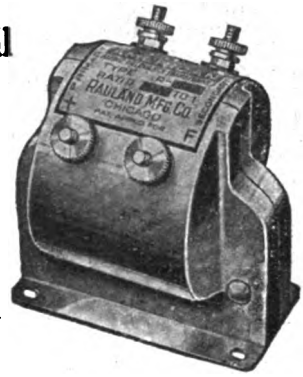
New Thrills from Radio

ALL-AMERICAN

Amplifying Transformers

Out-Distance and Out-Class All Your Radio Associates

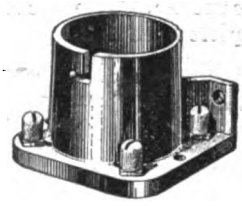
"All-American" Transformers will enable you to annihilate distance, defeat interference, and abolish extraneous noises. They faithfully amplify the tone-quality of both distance and nearby broad-casting stations with remarkable volume. "All-American" Transformers mean thrills and radio achievements worth talking about.



Audio Frequency Transformer

Equally adapted for use with new and old circuits and all tubes. Approved and officially adopted by leading makers of high class receiving sets. Standard in the industry.

Ask your dealer to supply you with "All-American" Transformers. Every instrument guaranteed to be electrically and mechanically perfect.



"All-American" Bakelite Tube Socket-base or panel mounting 75c

RAULAND MFG. CO.
200 N. Jefferson St. Chicago

FREE

"All-American" Book of Tested Hook-ups. Send 2 cent stamp for postage and give dealer's name and address.

ALL-AMERICAN

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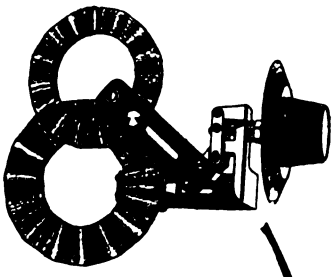
The E. J. Flewelling Tuner



Simplifies the building of a Radio set by eliminating loss producing taps and reducing tuning operation to setting of one condenser reading and adjusting tuner to maximum volume.

High efficiency is obtained by practically eliminating solid dielectrics from the coil field. Vernier control. Single hole panel mounting. Wide wave band covered without changing coil units.

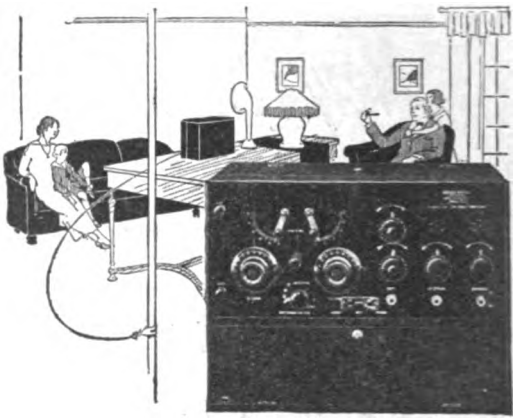
This is one of Mr. Flewelling's master designs. It will enable you to build an efficient set at a minimum cost. Requires little room but produces big volume reception. Price includes Tuner complete with dial.

SOCKETS

E. T. Flewelling Sockets will make your set more efficient. Price **$1.00.** At your dealer's or postpaid.

$8.00 / At Your Dealer's or Postpaid

BUELL MANUFACTURING COMPANY
2979 Cottage Grove Avenue
CHICAGO



—hook it to the waterpipe

Moon "Satterlee Antennaless" Radio will produce wonderful results simply connected to a waterpipe. No antenna, loop or indoor wire is necessary.

Stations within a conservative 1000 mile radius are regularly received with a non-power loud speaker on this set.

It is the ideal set for use in apartments, automobiles, yachts or railroad trains where an antenna is not practical. Extremely sensitive, unusually selective, yet simple to operate.

Write today for our folder "California or Newark"

MOON RADIO CORPORATION
501 Steinway Ave., Long Island City, N. Y.

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MOON
Satterlee
antennaless
—RADIO—

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Radio Catalogue Free—

Write us a post card—

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and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as $23.50.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

Headquarters for Radio

Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

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DAYTON, OHIO, U.S.A.

Variometers
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Audio Frequency Transformers
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Radio Frequency Transformers

Balanced Vernier Condensers

Equipped with Bakelite knob and dial.
Bakelite end plates.
Separate Vernier control.
Table or panel mounting.
Balanced rotor and stator plates.
Guaranteed not to short circuit.

Detector Units
—
Amplifying Units
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Rheostats
—
Potentiometers
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Knobs and Dials

VARIOMETER

Model 5017—23 plate—.0006 Mf.—$5.00
Model 5018—43 plate—.001 Mf.— 5.50
Model 5019—13 plate—.0003 Mf.— 4.50

Write for complete Catalogue

The Dayton Fan & Motor Co.
Established 1889
Dayton, Ohio

VARIOCOUPLER

Another Radio Achievement

"For the Grid of Your Tube"—Use

GREWOL VARI-GRID

An exceedingly small enclosed vernier variable condenser, taking up but 1¾" on your panel and absolutely replacing all 11 and 23 plate condensers!

TWO ARTICLES FOR LESS THAN THE PRICE OF ONE

The **Grewol Vari-Grid** is especially adapted for use as a variable grid condenser being equipped with a variable grid leak which can be removed if desired.

EVERY SET NEEDS AT LEAST ONE

You'll get a 100% improvement in distance and reception by using the **Grewol Vari-Grid** in your grid circuit. Try one in the aerial circuit too and across the secondary. They work wherever ordinary condensers are used. **And they have a vernier adjustment.**

You've plenty of room for two on your present set. They take up so little room, only one hole to drill.

At Your Dealers
Or Sent Direct Upon Receipt of **$2.25**

Write for folder

RANDEL WIRELESS CO.

4 Central Ave., Newark, N. J.

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FIL-KO-STAT CONQUERS DISTANCE

Full Resistance 30 Ohms

Takes the place of other rheostat or filament control without re-drilling holes in panel.

PUT A FIL-KO-STAT ON YOUR SET TODAY. You will hear stations you believed to be far beyond its range. You will get greater distance! Louder signals! Finer adjustment! NOISELESS OPERATION! *A. S. Allsup, of Kansas City, writes, "Since using my Fil-Ko-Stat I have picked up 5 stations I never heard before."*

The FIL-KO-STAT is the filament control of INFINITE adjustment, with a fine adjustment area 18 times greater than a wire rheostat, and several times greater than the next best filament control.

There are no screws to tamper with on the FIL-KO-STAT. No wires! No discs to chip or break! No adjustments to puzzle! Triple tested and adjusted at the factory to the ideal "off" for UV200, 201, 201A, WD11, WD12, UV199, DV6A, W. E. Peanut and *all* other tubes including 5 watt transmitting tubes. Hailed by amateur and professional radio men as the greatest step forward in the development of the tuning possibilities of the vacuum tube.

FIL-KO-STAT supremecy is proven by every test.

Price $2

In Canada $2.75

Recommended and sold by dealers in high quality radio supplies.

MADE AND GUARANTEED BY DX INSTRUMENT CO.

RADIO STORES CORPORATION
SOLE INTERNATIONAL DISTRIBUTORS
Dept. PR 12 218-222 West 34th Street New York

BEWARE Of Inferior Powdered Carbon Rheostats. Filkostat Resistance Element is 80% Metallic Substances.

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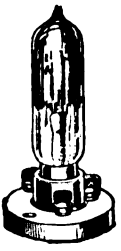
ELECTRAD PRODUCTS

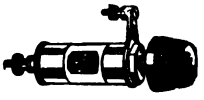
$2

socket 50c



Write for FREE Cockaday-Diode Reflex Circuit.

***The* NEW DIODE** A revelation for all reflex work. Replaces the crystal and overcomes all former difficulties of reflex circuits. Requires no adjustments for change of wave lengths. Gives you the clear reproductions of a crystal with the sturdiness and reliability of a tube. No "B" batteries required. Operates on less than ⅛ ampere from single dry cell. Easily adapted to Erla and all other circuits.

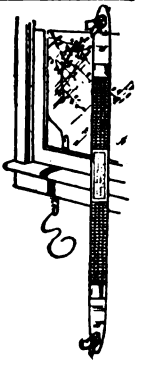


75c

***The* NEW VARIOHM** The latest invention in variable grid leaks. Each movement gives a definite new resistance. Positively does the work where others fail. A gradual resistance over entire range of ¼ to 10 megohms. Eliminates circuit noises, is moisture proof and non-microphonic. Ideal for use in Miloplex and other circuits. Guaranteed.

***The* LEAD-IN**

Fits right under closed window. Can be bent into any shape to fit ledges. Covered with fire-proof insulating material which prevents grounding of circuits on wet window sills. Takes the place of ungainly porcelain tubes and holes in the window sash. Fitted with Fahnestock clips. Always presents a neat appearance.



40c

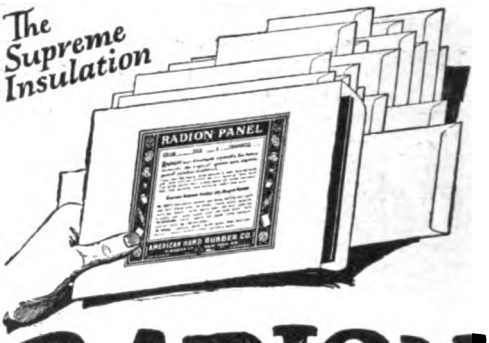
All products at your dealers, otherwise send purchase price and you will be supplied postpaid.

ELECTRAD, Inc.

428-C Broadway

New York

The Supreme Insulation



RADION Panels

are furnished in 18 stock sizes & —each packed in heavy envelope to protect beautiful finish. A size for every requirement

Every genuine RADION panel is stamped RADION. Do not accept substitutes.

6 x 7	7 x 12	9 x 14
6 x 10½	7 x 14	10 x 12
6 x 14	7 x 18	12 x 14
6 x 21	7 x 21	12 x 21
7 x 9	7 x 24	14 x 18
7 x 10	7 x 48	20 x 24

Radion being an insulation material especially made for wireless use, has the lowest phase angle difference, lowest dielectric constant, highest resistivity and supreme moisture, gas and acid repelling properties.

Sold by Radio Dealers Everywhere

American Hard Rubber Co.

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RADION

Panels-Dials-Knobs-Sockets-Insulators

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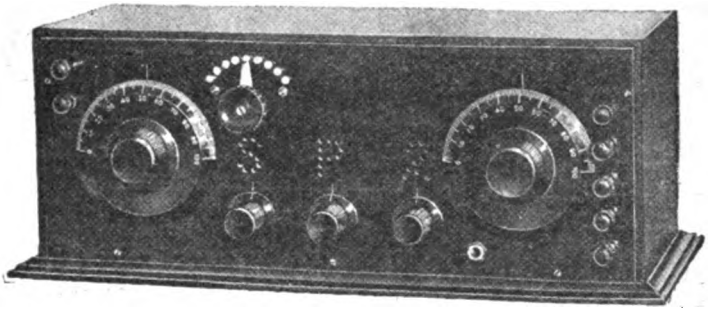
SP2

THE S P 2 RECEIVER—

Greater in Every Essential Than Other Receivers Costing Twice Its Price



In New York, in Chicago, in Philadelphia—wherever it is demonstrated—the S P 2 RECEIVER scores as the outstanding marvel of the radio world.

Greater in every essential than other Receivers costing two to three times its price. As great as any Receiver at any price.

Radio experts, where comparisons have been made, are as one in the opinion that the S P 2 is a real wonder of radio.

Larger, extremely more expensive Receivers remarkably eclipsed in performance, in every comparison.

S P 2 EFFICIENCY LEAVES NOTHING TO BE DESIRED. ITS REMARKABLY LOW PRICE MAKES IT THE GREATEST SELLING PROPOSITION OF THE DAY.

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PITTSBURGH RADIO SUPPLY HOUSE

963 LIBERTY AVENUE :: :: PITTSBURGH, PA.

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WEIGHS ONLY 8 OZ

The Scientific

THE PHONE IT TOOK A SOLID YEAR TO DESIGN

A $200,000.00 COMPANY stands squarely back of the guarantee on every *Scientific* headset

SEND NO MONEY!

20,000 TURNS EQUIVALENT TO 3,000 OHMS

Order TODAY by Postcard and Pay Postman on arrival

$2.95 POST-PAID

LOUD SPEAKER UNIT $1.95

We Guarantee The *Scientific* Headset to be the greatest value on the market. Try it for five days. If not satisfactory send it back and your money will be refunded immediately. Circular on request. Dealers wanted.

THE SCIENTIFIC ELECTRIC WORKS

98 Brookline Ave. DEPT. J BOSTON, MASS.

The Original AUTOMATIC TELEPHONE PLUG!

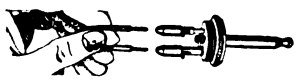
COMSCO BULL DOG GRIP PLUG

Eliminates COMSCO plug troubles

Saves you from short circuit and battery kicks. No more burned out phones or ruined transformers. No more broken finger nails.

Simple to operate **Bull Dog Grip Plug**

INSERT by a single touch, and the connecting tips of your phone cords accomplish automatically the most perfect electrical contact.



FOR ONE PAIR PHONES $1.00 FOR TWO PAIR PHONES $1.50

RELEASE by pressing the small knob and the tips will slide out easily without pulling the electrical contacts.

For sale at your dealer. Otherwise send purchase price to us and you will be supplied

GENERAL INSTRUMENT Co., 123 Liberty St., N.Y.C.

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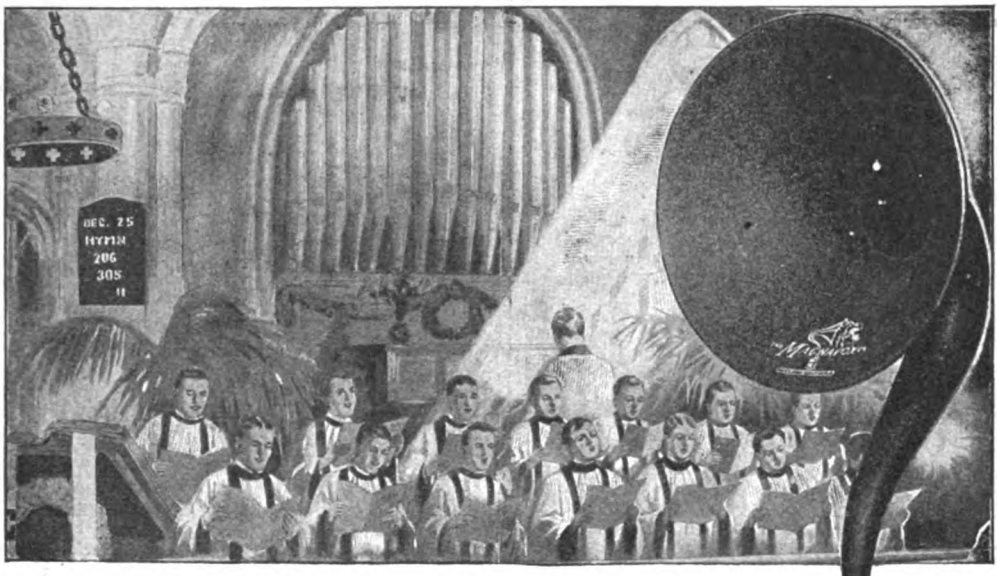

Magnavox brings you the Voice of all Christmastide

THE Art of Radio Reproduction is enjoyed by every Magnavox owner. Despite the ever-increasing quality and variety of Broadcast Programs, many a receiving set gathers dust unlamented because of insufficient sensitivity or an unsatisfactory "loudspeaker."

Every Magnavox owner is a master of the art of radio reproduction—the results obtained by the use of Magnavox Reproducers and Power Amplifiers cannot be equalled with apparatus constructed in the ordinary way.

The special attention of dry battery receiving set owners is called to the new Magnavox Reproducer M1, illustrated above.

Magnavox Reproducers

R2 with 18-inch horn . . .	$60.00
R3 with 14-inch horn . . .	35.00
M1 for dry battery sets . .	35.00

Combination Sets

A1-R Reproducer and 1-stage Amplifier	$59.00
A2-R same with 2-stage . .	85.00

Power Amplifiers

A1-One-stage	$27.50
AC-2-C-Two-stage	55.00
AC-3-C-Three-stage	75.00

Magnavox Products can be had of good dealers everywhere

THE MAGNAVOX CO.
Oakland, Cal.
***New York Office:* 370 Seventh Avenue**
Perkins Electric Limited; Toronto, Montreal, Winnipeg, *Canadian Distributors*

MAGNAVOX PRODUCTS

There is a Magnavox for every receiving set

12R

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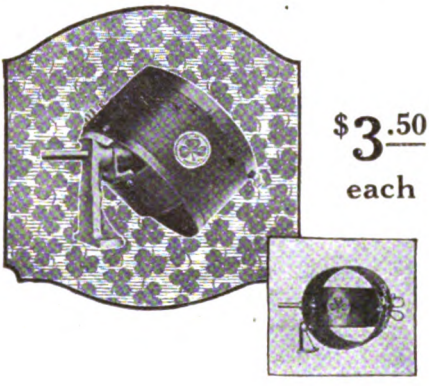
IMITATED BUT NEVER DUPLICATED



$3.50 each

DEPENDABLE –
for all new wave lengths

—Range 150 to 600 meters, tunes in on all new high wave lengths.

—180° type, gives double selectivity of ordinary 90° instrument.

—Tubes of genuine grade XX bakelite wound with single green silk covered wire.

—Angular movement of rotor gives super selective tuning with ease.

—Direct flexible leads to Fahnestock clips eliminate contact noises of spring contacts.

—Aluminum die cast frame reduces body capacity. For bench or panel mounting.

VARIOMETER
Write for descriptive specifications

Dealers write for trade prices

SHAMROCK MANUFACTURING CO.
320 Market St., Newark, N. J.

SHAMROCK
FOR SELECTIVE TUNING

180° VARIO-COUPLER
VARIOMETER

CONCERNING

BURGESS BATTERIES

The unique position of esteem and confidence occupied by Burgess Radio Batteries is a natural development of the conservative policy which has characterized the manufacture, advertising and sale of Burgess products.

Of interest, perhaps, to the thinking battery buyer is the fact that no Burgess product is advertised or sold until its merit has been proven, not only by our own rigid tests, but also those of the foremost radio engineers, manufacturers and experimenters in the country.

Through friendly criticism and suggestions, together with extensive research and engineering by the C. F. Burgess Laboratories the efficiency of Burgess Batteries has increased to a degree which we believe is not equalled elsewhere.

Ask Any Radio Engineer

BURGESS BATTERY COMPANY

ENGINEERS · DRY BATTERIES · MANUFACTURERS
FLASHLIGHT · RADIO · IGNITION · TELEPHONE

GENERAL SALES OFFICE: HARRIS TRUST BLDG., CHICAGO
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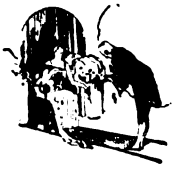
TUSKA RADIO

TUSKA POPULAR
No. 225

3-bulb Regenerative Receiving Set. Piano finish mahogany cabinet. Amplifier switch. Concealed binding posts. Armstrong circuit, licensed under Patent No. 1,113,149. Price, $75 without bulbs, batteries or loud speaker.

Ask for special circular No. 15-F describing this set.



Your entertainers are ready

Singers, bands, orchestras, speakers, organists, humorists—an unlimited host of performers are yours to command when you own a Tuska Radio. A simple adjustment of dials, and you can choose between them. Dozens of programs are in the air. Your Tuska will bring in whichever entertainer pleases you best and shut out all others.

Tuska owners are not obliged to tinker incessantly and add devices to correct construction faults. Their pleasure is unmarred by troubles. Every Tuska set is finished with exacting care by painstaking New England workmen—the best that live. Then it is examined and tested on distant signals by inspectors who are keenly critical. Both manufacturing and testing are under the personal direction of C. D. Tuska, a pioneer radio engineer.

For a dozen years before general radio broadcasting began, Tuska-made instruments were famous among radio experimenters for skillful design, superb workmanship and high efficiency. In the past two years, the demand for Tuska Radio has grown enormously. Each set in this increased production of today is as perfectly built as the finest Tuska instrument ever made—and yet, the prices are remarkably moderate for high-grade radio receivers.

Ask any first-class radio store to show you one of the models of Tuska Radio, priced $35.00 upward

The C. D. Tuska Co., Hartford, Conn.

Ogden, Utah, receives Troy, N. Y.

"In one evening, using Tuska 225 with one amplifier only, I received 19 stations, including San Francisco; Calgary, Alberta, and Troy, N. Y. Conditions were not abnormal, and the same stations were received again last night.—W. D. Garner."

TUSKA TRADE MARK REG. U.S. PAT. OFF. RADIO

Picks up Davenport the first time he tunes

"I never had my hands on a set until my Tuska came Saturday. First evening, I tuned in Pittsburgh, New York, Richmond, Ind., and Davenport, Ia. It certainly was great.—Wm. Parsons, Salisbury, Conn."

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only $7.50

Clear from the "Moon"

You want a Loud Speaker that will swell the sound volume of what your set brings in—without rasping, growling or harshness—so everybody can hear as agreeably as if all used head-phones. That's what you get with the

MOON LOUD SPEAKER

the most successful non-magnetic instrument

Dealers:

Boosts by enthusiastic users give you a fine repeat business on the Moon. Write for our proposition.

Two types, for single or double phone connections, same price. For use with your own phones. Heavy iron sound channels. Horn of heavy aluminum with beautiful black indestructible finish. Fifteen inches high. Hear it at your dealer's—if he isn't demonstrating the MOON, order direct from us on guarantee of satisfaction or refund.

Wilson Utensil Co.
Manufacturers — Dayton, Ohio

Transformation — from Back Alley Discord to Metropolitan Symphony

NOTHING IS WORTH WHILE UNLESS IT IS "RELIABLE"

SOUNDS like *sympathy* instead of *symphony* often trickle through the air to strike unappreciative ears. Many a classic has been mistaken for back aley discord simply because those sound waves had not been refined—"passed through the strainer" as radio slang puts it.

That's where "old Reliable" lends a helping hand, working in its obscure way. Reliable Transformers not only tend to bring distant stations within ear-range but every sound-wave receives a velvet touch of magic which makes the harshness, distortion and similar evils of radio receiving a thing of the past.

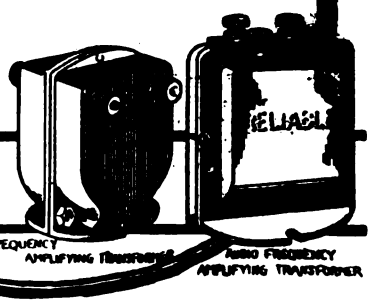
RELIABLE AUDIO and RADIO TRANSFORMERS

AUDIO Transformers furnished in three different stages of ratios—6 to 1, 4 to 1, and 2 to 1. Fully enclosed. Shielded type. Price $4.50 and $5.00

RADIO Transformers made in adjustable types with range from 150 to 1750 meters. Also fixed types. Price $2.75

ANOTHER BIG-IMPROVEMENT IN YOUR SET

Ask About Reliable Neutralizing Condensers. Only 75c



The Reliable Parts Mfg. Co.
2819 Prospect Ave. Cleveland, O.

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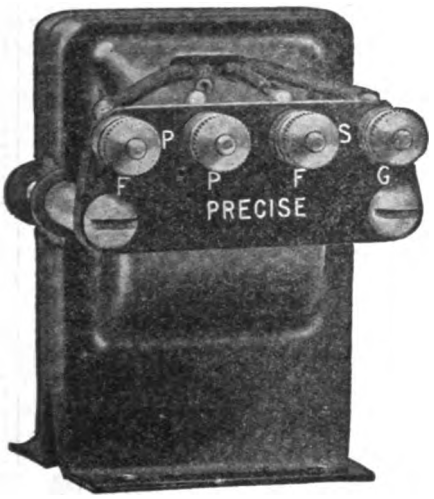
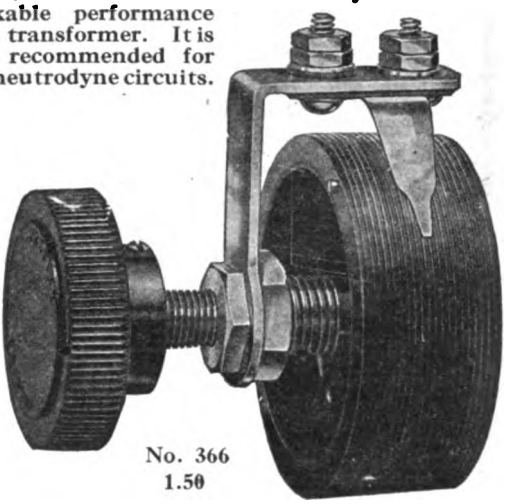
Precise Broadcasting—



Model 285A 5.75

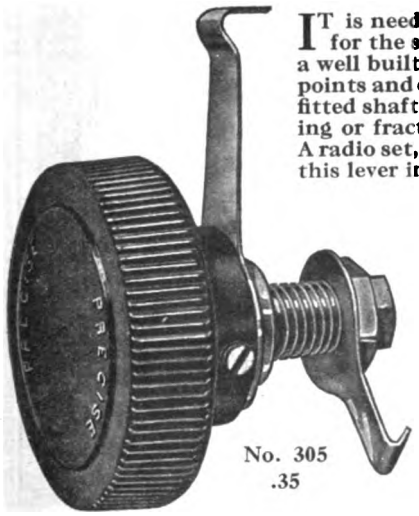
New Low Prices on Three Great Instruments

THE PRECISE AUDIO TRANSFORMER is recognized as a supreme achievement by radio engineers. Designed to produce maximum volume, realistic tone qualities and clear rendition of the low tones with the absence of distortion. The instrument is compact in design, neat in construction and appearance, and has a ratio of 4½ to 1. We will be glad to forward on request a copy of our voltage amplification chart 1094 which accurately records the remarkable performance of this transformer. It is highly recommended for use in neutrodyne circuits.



No. 366
1.50

THE IMPROVED PRECISE VERNIER RHEOSTAT assures smooth, noiseless, and sensitive control of the filament current. It also features single hole mounting, single knob control, zero to thirty ohms resistance, and is universal for all tubes. The Bakelite drum is wound with specially selected resistance wire. Turning the knob in either direction revolves the drum, which is guided by a fine pitched thread on the shaft, thus varying the resistance in the circuit. Select this instrument for your set and enjoy increased range, ease of clearing up or separating broadcasting stations.



No. 305
.35

IT is needless to ask why you solder connections on your radio set—for the same reason you should appreciate the importance of using a well built switch lever which will give positive wiping contact on the points and cut down current losses. Our switch lever features a closely fitted shaft bearing, a spring lever of special design to prevent weakening or fracturing under long service. The lever radius is 1⅜ inches. A radio set, like a chain, is no better than its weakest member. Install this lever in your set and note the difference.

TRIAL OFFER

If your dealer cannot furnish these, send us his name or on receipt of price we will forward you any instrument for ten days trial and will refund your money on return if unsatisfactory.

PRECISE MANUFACTURING CORPORATION

Rochester, :: :: :: New York

53 W. Jackson Blvd. Chicago, Ill. **Branches** **821 Market Street San Francisco, Cal.**

Distributed in Canada by Perkins Electric, Ltd.
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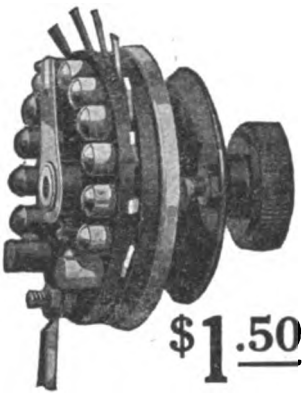
Sterling

12 POINT ROTARY SWITCH

The Last Link In the Perfection of the Radio Set



$1.50

Do away with unsightly front of board contact-points, and instead provide a complete unit for rear of panel mounting to which variocoupler taps may be soldered easily. The Sterling 12 Point Rotary Switch solves one of the radio builder's most vexing problems. It is the final perfection to assure satisfactory radio receiving.

It is held in place by two mounting screws, the heads of which are covered by the dial. Knob and dial mounted on adjustable shaft held by set screws for any thickness of panel up to ⅜ inch. **This Switch May Be Used With A Voltmeter For Reading Voltage On Individual Tube Filament.**

Other Sterling Radio Equipment

Portable Rectifiers Filament Rheostats
Audio & Radio Frequency Transformers
Filament Meters Pocket Voltmeters
"B" Battery Charging Attachments

The
STERLING MFG. CO.
2854 Prospect Ave. Cleveland, O.

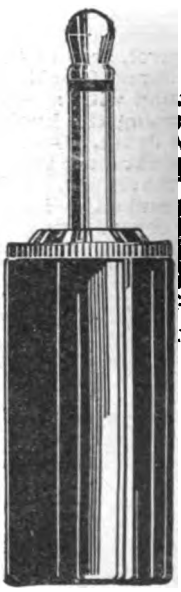
Look For The Green Box

CICO TWO WAY RADIO PLUGS are the largest selling round plugs in America because they are the best.

To eliminate any misunderstanding, CICO PLUGS are now available at reputable dealers' stores in an attractive and individual GREEN BOX with the word CICO on it.

CICO

TWO WAY RADIO PLUGS



Be sure you get THE PLUG IN THE GREEN BOX and you will be sure to get the best plug on the market today.

Price 60c

Consolidated Instrument Company of America, Inc.
41 East 42nd Street, New York

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The FERBEND TRADE MARK Wave Trap

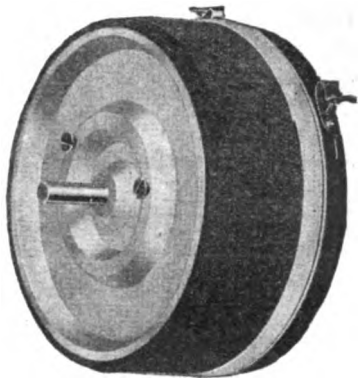
PATENT APPLIED FOR

STOPS INTERFERENCE

ANY NIGHT is "SILENT NIGHT" with a FERBEND!

With each locality operating its broadcasting station on its own wave-frequency, the possibilities for listening in on distant stations are now vastly increased compared with last year. Many owners of long-distance sets are, however, discovering that powerful amplification is of little value so long as local stations are "all over the dials." Here is the secret of the remarkable growth in popularity of the FERBEND WAVE TRAP. For example, a St. Louis user (name on request) brought in Havana on his loud speaker while *three* St. Louis stations were broadcasting. Similar results are uniformly obtained in all parts of the United States, with all makes and types of receiving sets.

Mounted on Formica panel in Mahogany finished cabinet 6 x 5 x 6
$8.50 Postpaid



Unmounted ready for panel mounting
$6.00 Postpaid

Send in your order now, or write for full information

Do not be misled by imitations. The FERBEND WAVE TRAP is the first inductive *as well as the* original *WAVE TRAP. It is not assembled haphazardly from standard parts, but is made up of special parts designed and manufactured by us for the sole purpose for which they are used.*

"The *Original* Wave Filter"

Ferbend Electric Company

21 E. South Water St. Chicago

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SAVE MONEY

Radeco Safety Fuses

"The biggest little thing in radio"

Price 50 cents
each postpaid

RADIO experts recognize that some means of protecting the delicate filament of vacuum tubes is necessary. Thousands of tubes are needlessly burnt out each year. Radeco Safety Fuses have been developed to prevent this waste. They are endorsed by the leading radio publications. You can now absolutely protect the tubes of your set by slipping a Radeco Fuse on one of the filament terminals of each of your tubes.

Guaranteed not to interfere with the efficiency of your set. Save money by ordering today one fuse for each of your tubes. Mention type of tube.

DEPT. 2

RADIO EQUIPMENT COMPANY
20 Stuart Street, Boston, Mass.
New England's Oldest Exclusive Radio House
Distributors of many other successful radio specialties

READ WHAT ONE MAN SAYS

939 Dunlop Avenue
Forest Park, Illinois

Radio Equipment Company,

Gentlemen: About last January I purchased some of your Radeco Safety Fuses. I have never had cause to regret this purchase, because I believe it has saved me many dollars. So I am writing to thank you and will recommend them to my Radio friends. The fuses have not interfered in any way with the operation of my set, and you are entirely at liberty to use this letter as an "ad" for your product, if you should so desire. Wishing you success in your present enterprise, I am,

Yours truly,
Mr. Harvey F. Reese.

9/26/23

DEALERS: We are going to appoint live distributors. Write for our proposition and full details.

Raven Super 180 Degree Coupler
Catalogue No. B-104

RAVEN RADIO

We are now making a 180 degree coupler which is the last word in coupler construction. This instrument is made of Red Moulded Bakelite thruout, including the Bracket. The only metal used is in the two binding posts and the shaft to hold the rotor. These are made of Nickled Brass.

This instrument will not only measure up to all "RAVEN PRODUCTS" but it will stand out on the market as the *Best 180 Degree Coupler* of the day.

EVERY RAVEN INSTRUMENT IS UNCONDITIONALLY GUARANTEED

All Instruments are thoroughly inspected before leaving our factory and any purchase made by a Jobber, Retailer or User found defective in any way, will be replaced by us with a new instrument free of charge to the purchaser.

Radio jobbers and dealers should write for our prices and descriptive literature on our complete line.

Bakelite Variometer	**B-101**
Bakelite Vario-coupler	**B-102**
Bakelite Tickler Coil	**B-103**
Bakelite 180° Coupler	**B-104**
Bakelite Rheostat	**B-106**
Wooden Variometer	**C-101**
Wooden Tickler Coil	**C-103**

RAVEN RADIO, Inc. 8 Learned Street, ALBANY, N. Y.

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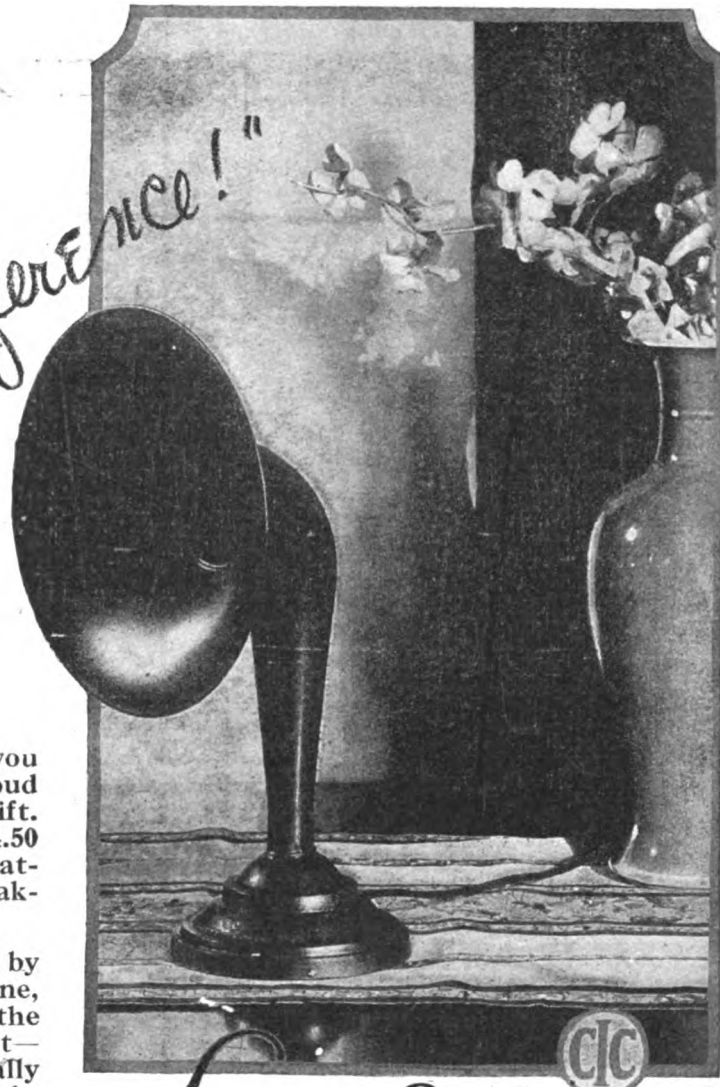
"Listen to the Difference!"



THIS Christmas, you can give the C.I.C. loud speaker as a treasured gift. Its cost is low—only $14.50—and its efficiency is greater than many loud speakers at twice the price.

It is distinguished by small size, grace of line, beauty of tone equal to the famous C.I.C. head set—and it is unconditionally guaranteed. Send for booklet—or "Listen to the Difference" at your dealers.

CIC

Loud Speaker Facts

A booklet will be sent on request.

CONNECTICUT INSTRUMENT CO.

STAMFORD, CONN.

Distributed in Canada by **Perkins Electric Ltd., Toronto, MONTREAL, Winnipeg**

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Send 50c for this FADA NEUTRODYNE BOOK

It tells in simple language how to construct a Neutrodyne circuit receiver using FADA parts. Nothing is left in doubt. Both four and five tube Neutrodyne wiring diagrams are included. In addition, in the rear of the book there are both four and five tube full size paper panel drilling templates.

This 32-page book and the use of FADA Neutrodyne and standard parts will insure successful Neutrodyne circuit receiver construction.

F. A. D. ANDREA, INC.

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The special FADA Neutrodyne parts including three Neutroformers, two Neutrodons and the HOW-TO-BUILD-IT book sell for $25.00.

SPECIAL OFFER!

Good for 30 days only

Two **new subs. to POPULAR RADIO for only . . . . . $3.**

TAKE advantage of this Special Offer! It means a big saving to you.

You and a friend of yours may have POPULAR RADIO for a whole year, provided you are both *new* subscribers.

Just wrap your check for $3 around the double coupon and mail it to-day before the price goes up.

Soon a subscription for *one* year will cost as much as you need now pay for these *two* subscriptions. But you must act at once!

(***Coupon good only until December 15th, 1923***)

POPULAR RADIO, Dept. 122
9 East 40th Street, New York City

Please send POPULAR RADIO for one year to:

NAME.....

ADDRESS.....

CITY:.....STATE.....

And also to this other new subscriber. Here's my cash remittance— (or a check or money order for $3.00).

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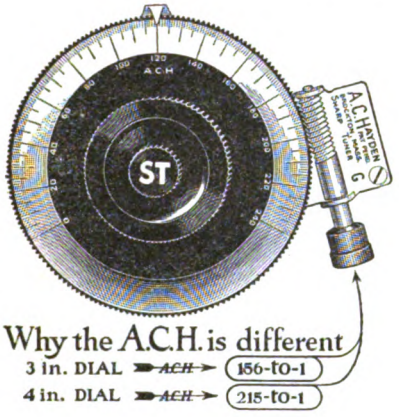
A PLEASANT SURPRISE

Awaits the User of the

A. C. H. SHARP TUNER DIALS



ROUGH TUNING OR 1,000 OF AN INCH IN EITHER DIRECTION

CAN BE INSTALLED AND WILL IMPROVE ANY RECEIVING SET MAKING DIFFICULT TUNING EASY

Price 3 inch size.....$2.50 complete
Price 4 inch size.....$5.00 complete
Regular fitting 5/16 shaft 1/4 and 3/16, 5 cts. each, extra

Money Back Guarantee

The principal of the A. C. H. Sharp Tuner has only been embodied on very expensive instruments where the most delicate adjustment is necessary and then as a permanent part.

Extra Advantage of the A. C. H.

1. Can be attached or removed from any instrument.
2. Rough tuning same as any dial.
3. Movement so fine that the eye cannot detect but the ear can
4. Automatically locks instrument so no jar can disturb it.
5. Dial grounded reducing body capacity to a minimum.
6. Special dial 2 graduations where ordinarily one.

Mail orders sent prepaid in U. S. A.

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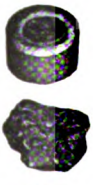
Make Your Reflex Set 100% Efficient by Using

MPM
Million Point Mineral CRYSTAL
and
MPM
Reflex Radio Frequency TRANSFORMER

Price $4.50

M. P. M.
Reflex Radio Frequency
TRANSFORMER

Absolute precision in the assembling of these transformers assures remarkable range and volume with positive elimination of distortion.



Prices
Mounted 35c
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M. P. M.
Million Point Mineral
CRYSTAL

Super-sensitive—reproducing from every point on its surface. Greatly increases both audibility and radius. Will not burn out or corrode. M. P. M. Crystal is unsurpassed for reception both with or without amplification.

SPECIAL FREE OFFER

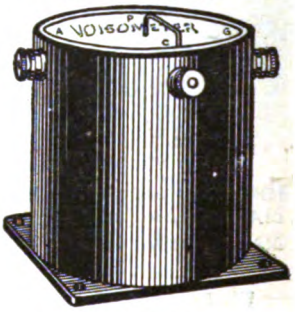
Detailed working diagram of a successful reflex circuit will be sent free with all orders for either crystals or transformers.

M. P. M. SALES CO.
Dept. P
247 S. Central Ave., Los Angeles, Cal.

SOMETHING NEW!
IN RADIO

COAST TO COAST
AND
HAVANA, CUBA
WITH A

VOISOMETER
PRICE $5.50



ELIMINATES
THE
VARIOMOTOR
VARIOCOUPLER
AND OTHER PARTS

The Voisometer is extremely Simple in Appearance and Operation. You save two or more parts of a tube set a saving of 70 per cent for the Radio Fan.

The only parts used in the Voisometer Sets are as follows.

VOISOMETER
VERNIER RHEOSTAT
GRID LEAD
TUBE SOCKET
VERNIER VARIABLE
CONDENSER
WITH A COMPLETE WIRING
DIAGRAM

Every Voisometer Tested and guaranteed

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SALES CO.
SOLE DISTRIBUTORS
112 NORTH 7th STREET, ROOM 401
ST. LOUIS, MO.

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Na-ald Special Socket No. 499 for UV-199 and C-299 Tubes. Price 50c

Na-ald Adapter No. 429 For UV-199 and C-299. Tubes. Price 75c

De Luxe No. 400 Price 75c

Small Space No. 401 35c, 3 for $1.00

Na-ald W.D. 11 No. 411 Price 75c

It's the contact that counts

A CAREFUL examination will show that each contact in Na-ald sockets and adapters is of a wiping nature on a broad surface, and so designed that strong tension is permanent, no matter how often the bulbs may be removed or how much the connecting prongs in the tubes vary. Na-ald Sockets are moulded of Bakelite with uniform cross-section, cure and other engineering features incorporated, to avoid plate to grid losses and to insure that each tube develops its fullest efficiency.

The new Na-ald dials combine rare beauty of design with highest efficiency in use. These dials are moulded from genuine Condensite in such a way that absorption losses are reduced to a minimum. Knobs are so shaped that fingers do not conceal clear numerals and graduation on the bevel of Na-ald dials.

Na-ald Circuit Booklet packed with each Na-ald product

Write for "Why a Bakelite Socket?" and other descriptive literature

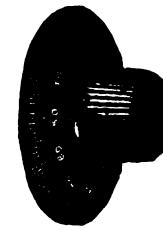
Alden Manufacturing Company

Manufacturers of sockets and dials for every radio requirement

Dept. C **52 Willow Street**

Springfield, Mass.

Cable Address, Aldenco



No. 3023—4 2 Inch 35c, 3 for $1.00

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No. 3783—4 3½ Inch Price 75c

Na-ald Knob No. 3153—4 Price 50c

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extreme selectivity—

A single tuning adjustment—assuring the greatest degree of program selectivity—enabling one to tune in desired stations and enjoy their broadcasting without the slightest sign of interference by other stations, is one of the features of

Melco-Supreme

The Tuned Radio Frequency Amplifying Receiver that also

PRICE ONLY **$140**

Complete knock-down parts for **Melco-Supreme** including drilled engraved Bakelite panel and solid mahogany cabinet

PRICE $90

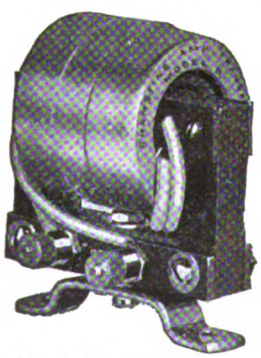
1. Operates with merely a 10 FT. WIRE—not even a ground necessary.
2. Offers exceptional CLARITY without the slightest loss of tone quality.
3. Affords real LONG DISTANCE by covering all Broadcasting ranges from 180 to 610 meters.

We also manufacture a complete line of standard parts under the Amsco Brand. Write for our complete descriptive literature.

AMSCO PRODUCTS, Inc.

Broome and Lafayette Streets **Dept. P.R.** **New York City**

RHAMSTINE*



Model B Amplifying Transformer

$4.00 *Postpaid*

For UV 199

use the Model B

Amplifying Transformer

to secure the greatest efficiency. Each transformer is guaranteed to give satisfaction. Order yours today.

The Victophone

$7.50 *Postpaid*

for your Victrola or Columbia at $7.50 is the equal of some loud speakers costing much more. Special fittings can be provided for other makes of phonographs, or the unit can be used with a loud-speaking horn. A Victophone is the solution to your loud-speaker problem. Immediate deliveries.

Manufactured by

J. THOS. RHAMSTINE,* Woodbridge at Beaubien Detroit, Mich.

Maker of Radio and Electrical Products

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SIGNALING

CONSIDER the vast difference between the methods of the savage and the marvellous broadcasting of today. This difference can be stated in one word —instruments.

Modern broadcasting employs delicate instruments to transform messages into electricity. Satisfactory reception requires equally fine apparatus to translate this current into the original music or spoken word.

Upon your loud speaker or head phones falls the task of transforming the electric current that flows through your set into sound. Poorly designed or carelessly constructed instruments cannot do this with satisfaction to you.

Holtzer-Cabot Phones and Loud Speakers are the perfected results of 25 years' specialization in the manufacture of sensitive electric apparatus.

Holtzer-Cabot Loud Speaker, $25.00
No. 2 Universal Head Phones, 9.50
No. 4 National Head Phones, 6.00

Write for booklets, "What you should know about Radio Reception" and "A better Loud Speaker."

THE HOLTZER-CABOT ELECTRIC CO.
125 Amory Street, **Boston, Mass.**
6161-65 South State Street, **Chicago, Ill.**
Department B

Holtzer-Cabot
BUSINESS ESTABLISHED 1875

HEAD SETS

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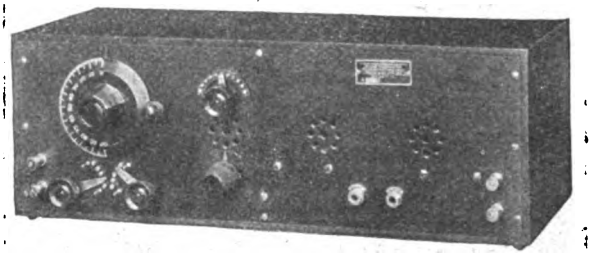
The New "Penn C" Receiver. Type GT 2.

A "COAST TO COAST SET" THAT ANY NOVICE CAN OPERATE

Plenty of volume to operate any good loud speaker

List Price
$78.50
Without Accessories



Efficient
Selective
Regenerative
Easy to Tune

A Three Tube Set That Stays Sold

Licensed under Armstrong Patent
No. 1,113,149

PENN-C RADIO ELECTRICAL

Established 1910

Three Other Models

Dealers, Write Us

PENNSYLVANIA WIRELESS MFG. COMPANY
NEW CASTLE, PENNA.

"Regal" Radio Products—Fit for a King

New "REGAL" Items for the 1923-1924 Season

New "Regal" No. 162
Double Arm Inductance Switch

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of hole. No more chipped panels. Complete with hard rubber Knob and Dial

$1.50

New "Regal" No. 200
Audio Frequency Amplifying Transformer

For clearness of tone, amplification of voice and music from nearby and distant broadcasting stations, is unequaled by any Transformer on the market

3½ to 1 Ratio..... **$4.50**
5 to 1 Ratio..... **4.75**

New "Regal" No. 120
Vernier Rheostat

For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market. Complete with Knob:

6-Ohms..... **$1.25**
30-Ohms..... **1.25**

If your dealer does not carry "REGAL" Products, write us direct

(Send for Catalog No. 24, showing 30 Big "REGAL" Items)

THE AMERICAN SPECIALTY COMPANY - Bridgeport, Conn.

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Precision Adjustment of Coupling Brings in Distant Stations

With CURKOID Couplers elusive distant stations can be tuned in easily and to full volume.

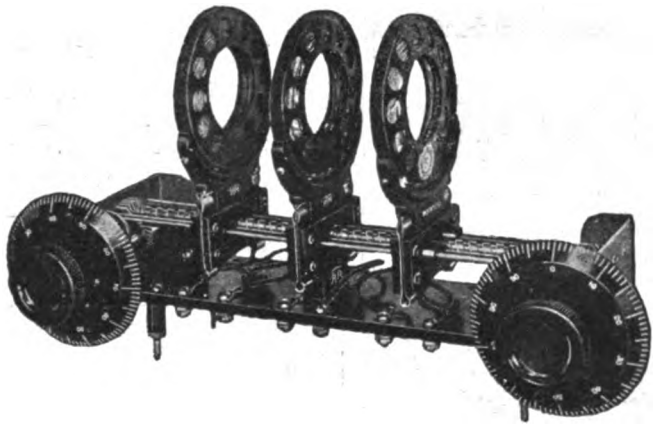
CURKOID Couplers give you *eight times* more accurate control over regeneration than the average variometer and variocoupler. You can take full advantage of regeneration when receiving distant stations without risk of having your set oscillate at the very point of maximum volume.

Coils mounted on CURKOID Couplers move *but one four hundredth of an inch* for each graduation of the dial. The accurately made and finely finished worm drive moves the coils over a range of four inches. This gives you looser coupling than you can obtain with any existing form of mounting. Yet when the coils are as close together as the mounting permits, it is practically equivalent to conductive coupling.

CURKOID interchangeable inductances, which slip into these mountings without fuss or fumble, are the most efficient inductances yet devised. They are wound in the form of the curtate epitrochoid—a circle with a constantly progressing center. Adjacent turns are widely separated yet the winding is concentrated over a limited area, giving minimum distributive capacity and an intense magnetic field. Every CURKOID inductance, no matter how many turns, has the same inside and outside diameter. Minimum resistance, minimum distributive capacity and maximum inductance give the greatest efficiency and selectivity.

CURKOID Dual and Triple Couplers are adapted for use with any circuit.

Send ten cents for booklet showing how to make single and coupled circuit sets, tuned and untuned radio frequency, neutrodyne, regenerative, super-regenerative, the Cockaday, Reinartz and other sets.



The CURKOID Radio Frequency Unit solves the radio frequency problem. It is the only radio frequency unit which has adjustable coupling and is adapted to any make of tube and wavelength by means of CURKOID Interchangeable Coils. Ideal for tuned and untuned radio frequency. CURKOID Coils give maximum transformation of energy without the usual capacity and resistance losses. Enjoy real efficiency and absolute control of your radio frequency amplifier by using a CURKOID worm driven adjustable coupler with CURKOID inductances.

RIEGER RESEARCH CORPORATION

114 WEST 44th STREET
NEW YORK

CURKOID PRICES

Radio Frequency Mounting	$2.75
Triple coupler	7.50
Dual coupler	4.50

20K inductance	$1.40		50K inductance		1.60
25K	"	1.50	75K	"	1.65
35K	"	1.50	100K	"	1.70

(Made up to 1500K)

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Goods

Distributors for

Radio Corporation of America	
Grebe	Western Coil
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We carry a comprehensive stock of the latest receiving sets, parts and supplies of the leading manufacturers, and ship from stock promptly.

FREE CATALOG *Illustrated, sent on request*

DEALERS: Buy reliable equipment from a house of established reputation. Send for catalog of tested and approved apparatus, and our discount sheet.

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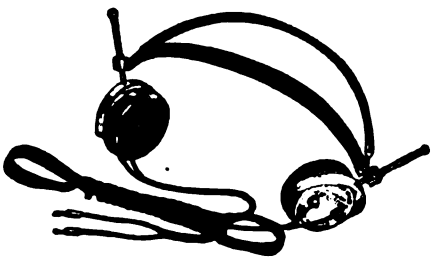
ANDRAE *In Business Since 1850*

AMPL-TONE PHONES



ALWAYS FRESH
Sample to dealers $3.20

This is our only ADVERTISEMENT

It sells our entire product
Merit does the rest for us

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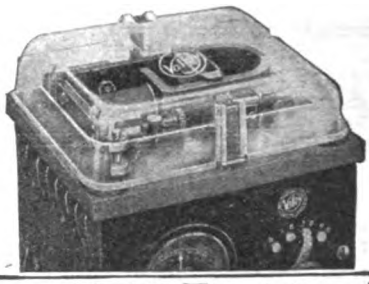

For All Batteries

The one charger which re-charges all radio storage batteries—2-volt peanut tube batteries, 6-volt A Batteries, 6 and 12 volt Automobile Batteries, and 1 to 4 B Batteries. It's the new Valley Type A B C Battery charger.

Plugs into regular electric light sockets. Takes about a dime's worth of current for an average charge.

A lot of people were disappointed last year because we could not make enough Valley Chargers. We are making more this year, but with the improvements, they will be in greater demand. Don't miss out. At all good radio dealers.

VALLEY ELECTRIC CO.
3157 S. Kingshighway - St. Louis, Mo.

Valley Battery Charger

FREE RADIO
VACUUM TUBE SET

Receives 100 Miles or More

Send name and address. Learn HOW you can get a Vacuum Tube Radio Set **ABSOLUTELY FREE**
Write today for Free Radio Plan.
RELIABLE SALES CORP.
434 Broadway, N.Y.City. Dept.582

FOR BETTER RESULTS
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SOLID COMFORT

Comes With The Use Of The

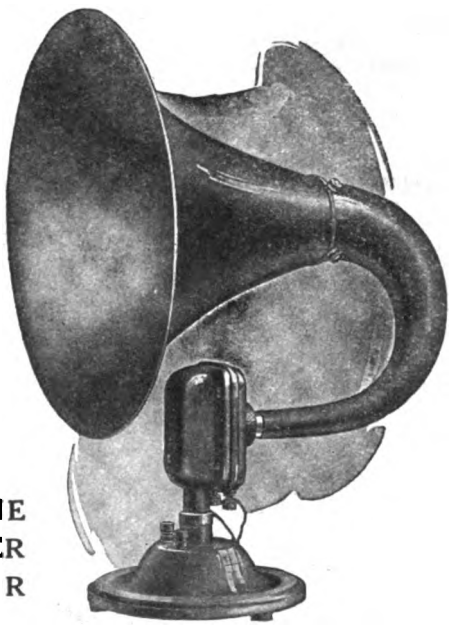
TRADE MARK
AUDIOPHONE
REG. U. S. PAT. OFFICE

because nothing is lost from the original broadcasting

Not only is it easily possible to distinguish the words of the speaker, but also the minute graduations in pitch, timbre and quality of overtones which distinguish individual voices.

The Audiophone is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use on connecting to your receiving set. It will prove a source of lasting pride and pleasure.

Audiophone Sr.....Price $32.50
Audiophone Jr.....Price 22.50



BRISTOL ONE STAGE POWER AMPLIFIER

If greater volume is desired, over what you already obtain, use the Bristol One Stage Power Amplifier. No C Battery required
Price $25.00

THE BRISTOL COMPANY
WATERBURY, CONN.

THE BRISTOL COMPANY
Waterbury, Conn.

Please send me without cost or obligation to myself, Bulletins Nos. 3006 and 3011-L on Bristol Audiophone and One Stage Power Amplifier.

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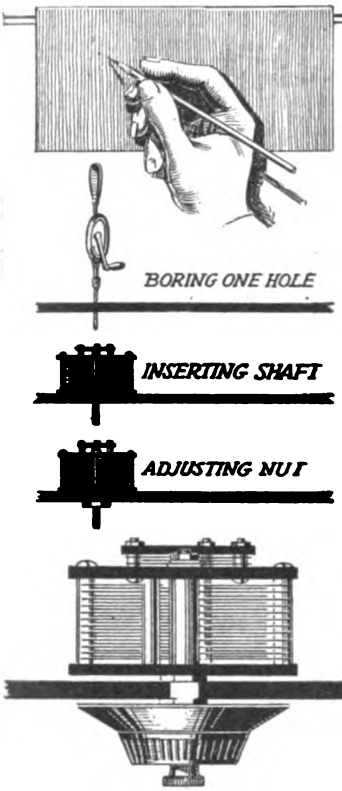

RATHBUN

SINGLE-HOLE MOUNTING

SUPERIOR CONDENSERS

TURN the dial of a **Rathbun Condenser** and notice the absolute lack of side or end play, and the perfect alignment of plates at every point. Yet it turns easily and smoothly because of the **extra long brass bearings.** Such bearings wear longer so that **Rathbun Condensers** retain their positive alignment indefinitely. Send for the name of the nearest Rathbun dealer and folder that explains all the points of Rathbun Superiority.

LIST PRICES—RATHBUN CONDENSERS

PLAIN TYPE			
5 Plate	.000125	$3.00
11 "	.00025	3.00
23 "	.0005	3.50
43 "	.001	4.50

VERNIER TYPE		
3 Plate	.000075	$1.00

COMBINATION VERNIER TYPE		
3-11 Vernier	Variable	$4.50
3-23 "	"	5.00
3-43 "	"	6.00

RATHBUN MANUFACTURING CO.
Jamestown, New York

"RESIST-O-METER" MEANS PERFECT RESISTANCE CONTROL

TYPE-2A

PERFECT ELECTRIC CONTROL
RESIST-O-METER
TRADE MARK

Ideal Filament Control Over All Receiving Tubes

(Also 5 Watt Power Tubes)

RANGE 0—60 OHMS

Complete vernier action over entire range.

Non-packing fibrous cushion type of resistance variation.

Positively silent in operation.

Size back of panel, 2⅜", diameter 1⅛".

PRICE $1.80

SCHOLES RADIO & MFG. CORP., 32 W. 18th St., N.Y.

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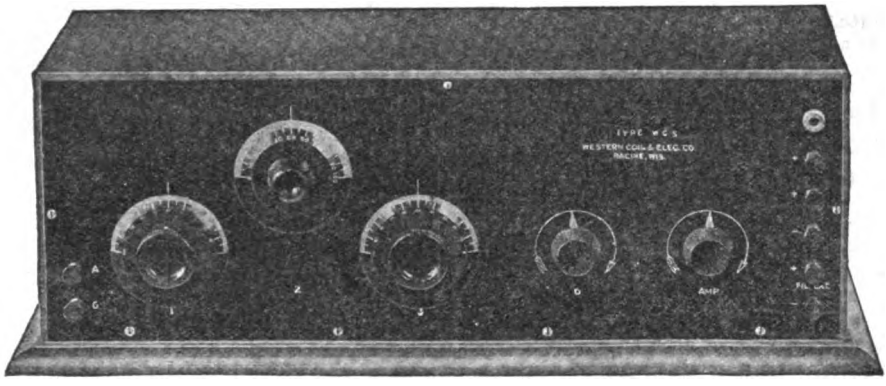

The Most Practical Set For Low Wave Specialists

Are you having trouble getting short wave signals? The WC-5-SW shown above picks up signals on wave lengths from 90 to 380 meters sharp and clear. It is built by and for short wave specialists. The price is $85.00.

WC-5-SW

Built especially for Transmitting Amateurs

The WC-5-SW is a 4 tube set. One stage of tuned Radio Frequency amplification is employed ahead of the detector to make it super-sensitive. Two stages of audio frequency are used to bring up the signal strength. Uses any type of tubes. Gives perfect control of audibility. Detector rectifies only. Uses antenna compensating condenser. Only two control adjustments. Pure negative biasing on all tubes, thus marked saving on B Battery current. Tuned Radio Frequency sharpest known and most selective principle ever adopted. Plate potential non-critical. Mono-block tube socket. No grid plate leads on audio amplifiers. Audio amplification absolutely necessary when using low efficiency receiving antenna, i.e., underground or indoor. Mahogany cabinet, piano rub finish. Rabbited-in panel. Split lid cover.

Write for complete description and illustrated folder on this practical set for low wave specialists. All transmitting amateurs will be interested in this literature.

OTT RADIO, Inc.

222 Main St. **La Crosse, Wis.**

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A New Discovery!

EXTREME SUPER-REGENERATION is obtained without noises through

FRESHMAN

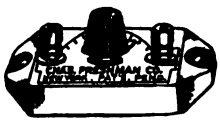
Variable Resistance Leaks

by connecting between plate and Grid of the tube as disclosed by the sensational

New Kaufman Circuit No. 2

PANEL TYPE

Only the Knob Shows on the Panel



BASE TYPE

Absolutely No Pencil Markings

Freshman Resistance Leaks are especially built for use as tuning instruments: Construction is such that they will withstand unusual usage, Freshman Leaks give an unbroken range of 180 degrees from 0 to 5 megohms. Absolutely guaranteed. **Enables you to get stations you've never heard before.**

Either Type

Complete with either .00025 or .0005 mfd. Mica Condenser . $1.00
Without Condenser 75c

At your dealers—otherwise send purchase price and you will be supplied without further charge.

Ask your dealer or write direct for free diagram showing how you can convert your single tube circuit into the new sensational Kaufman Circuit No. 2.

Chas. Freshman Co. Inc.
Radio Condenser Products
106 SEVENTH AVENUE, NEW YORK

It charges them all!

HANDY CHARGER

A Battery Charger that employs no contacts that stick and give trouble, no liquids nor bulbs—yet charges 6 volt batteries at 5 to 7 amperes and also charges 12 volt batteries and from 1 to 4 "B" batteries at a time. Beautiful metal case—panel with convenient terminals for each size battery and Weston Ammeter.

If it doesn't charge 'em all, it isn't a

Handy Charger
List $18.00

Interstate Electric Company
of St. Louis, Mo.
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EDSON

Tone Tested Radio Headsets

THE lowest-priced first quality headset on the market today. Compare with headsets costing twice our price. Return ours if not satisfied. Our written guarantee protects you. **Send $3.00 by registered mail or money order.** Buy direct of us and save the difference. We ship, postage prepaid, same day order is received. Ask for our

Free Catalog of Radio Parts

EDSON RADIO SALES CO.
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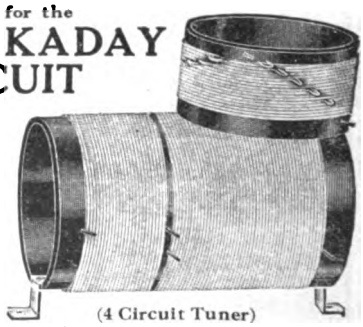
EASTERN COIL SETS

for the

COCKADAY CIRCUIT



(4 Circuit Tuner)

are now a standard, and in universal use, due to their efficiency in this wonder circuit.

Made as per specifications of Mr. Cockaday, using No. 18 wire with D coil bank-wound.

COMPLETE ASSEMBLED SET OF B, C AND D COILS. $2.75

Hook-up, directions and material list furnished FREE with each set of coils.

Mail Orders Filled. Dealers Communicate.

EASTERN RADIO MFG. CO.
22 Warren Street, Dept. P. R. NEW YORK, N.Y.

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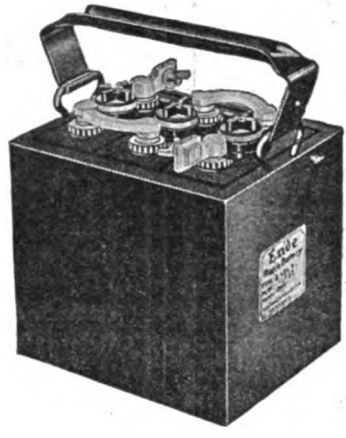
Will your battery stay for the concert?



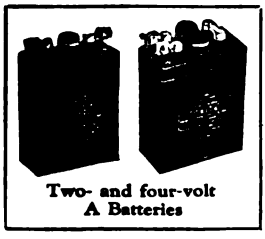
THERE is nothing more exasperating than a battery that "signs off" just when you are enjoying a splendid radio concert.

A good A battery should supply uniform filament current during a long period of discharge. Frequent recharging and replacements take all the fun out of radio receiving.

When you hook up your set to an Exide A Battery you'll appreciate what ungrudging battery service means. You'll be impressed time and again with the value of its ample capacity-rating and the smooth, unvarying flow of current that it delivers to your tubes.

Features you will appreciate

From its heavy, well-made plates to its convenient terminal binding posts, every detail of the Exide's construction is designed to help you get better reception. Vent plugs that may be inserted or removed by a single twist of the wrist make it an easy matter to add water or test the battery. A deep sediment space in the bottom of each cell eliminates danger of internal short circuits or reduced life. Wood separators of the same fine quality that are found in the Exide automobile batteries insulate the plates from one another and also contribute to the battery's long life. A stout detachable handle across the top of the battery makes it extremely easy to carry.



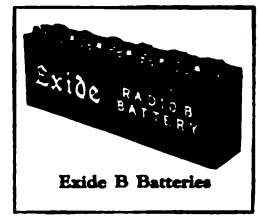
Two- and four-volt A Batteries

Two low-voltage A batteries

The Exide line has been extended to include two low-voltage A batteries, consisting of one and two cells. They are designed specifically for WD-11 and UV-199 vacuum tubes, and are right in line with recent developments in radio receiving.

The two-volt Exide A Battery will heat the filament of a quarter-ampere tube for approximately 96 hours. The four-volt Exide A Battery will heat the filament of a 60 milli-ampere tube for 200 hours.

Exide B Battery



Exide B Batteries

Current from the new Exide B Battery is full-powered and noiseless. It is free from fluctuations that cause hissing and crackling sounds in your phones. When you tune in distant stations you know that your satisfaction will not be marred by imitation static that sounds as though a heavy electrical storm were in progress.

You don't have to put up with a battery that discharges quickly. Go to any radio dealer or Exide Service Station and ask for Exide A and B Batteries.

If your dealer cannot supply you with free booklets describing the complete Exide line of radio batteries, write to us.

Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Oldest and largest manufacturers in the world of storage batteries for every purpose

Service Stations Everywhere — Branches in Seventeen Cities

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Approved!

A FISCHER PRODUCT

EVEN THE EXPERTS LOOK NO FURTHER—*They Know*

This 180° Multi-Coupler is splendidly built, Bankwound, with a wave length of 800 meters, 5 Soldered Leads, Bankwound Stator on genuine Bakelite Tubing, Kiln Dried Rotor, Fahnestock Spring Clip Connections, Aluminum Mounting Base, Non-conductive Adhesive.

20 DIAGRAMS $4.50 FREE WITH EACH

For sale at your dealer's—otherwise send the $4.50 directly to the Manufacturer and you will be supplied postpaid.

G. H. FISCHER & CO.
123 Liberty Street New York City

Fall in Line
USE RAYCOILS
for Distance and Volume

RayCoils "A" for Reinartz, Ray Coils "B" for RCS and Ultra Audion Circuits, RayCoils "C" for RCS, Ultra Audion and Tuned Radio Frequency for All Circuits.

A = $2.50
B = 2.00
C = 2.00

Use the RCS Circuit with or without Radio Frequency for Simplicity in operation and results. Not equalled by any set for volume and distance.

Coils in Separate Box With Wiring Diagram

Working **Blue Prints** of four sheets 12 x 18 of all standard circuits, such as The Variometer, Reinartz and RCS one and three tube sets. 50 cents a set.

If your dealer cannot supply you, send direct to us and we will mail them post paid anywhere in the U. S. A.

R. C. SCHOONHOVEN
Major Q. M. R. C.
ELGIN, ILL.

U.S. TOOL CONDENSERS

Precisely Lathed Shafts
Insure Exact Alignment

The bearings, where continued use **first** tests the quality of a condenser, in **U. S. Tool Condensers** are machined as carefully as the parts of the finest precision instruments. The main rotor shafts fits its bearings with just a micrometer determined space between to give smooth, frictionless turning, but without enough space to allow side or end play. Consequently wear is reduced to insignificance. Another reason why all **U. S. Tool Condensers** are so unconditionally guaranteed.

Write for booklet and the name of your nearest dealer.

U.S. TOOL COMPANY INC. *116 Mechanic St. Newark, N.J.*

The Three Best Radio Bargains

All good dealers carry Murdock Radio Apparatus because it is standard the world over—made right—priced right. If your dealer cannot supply you, send your order direct.

MURDOCK HEADPHONES

Will give you better satisfaction than phones costing more money and will last longer. Now priced at

$4.00 and $4.50

MURDOCK LOUDSPEAKER

Absolutely complete. A clear toned, practical loudspeaker at a very low price. You should have one. (Not suited to crystal sets.)

$5.00

NEW MURDOCK PLUG JACK

You need one of these. It enables you to connect four pairs of headphones at once. Low in price, but of best quality. **$1.00**

Wm. J. Murdock Co.
354 Washington Ave., Chelsea, Mass.
Sales Offices: Chicago and San Francisco
STANDARD SINCE 1904

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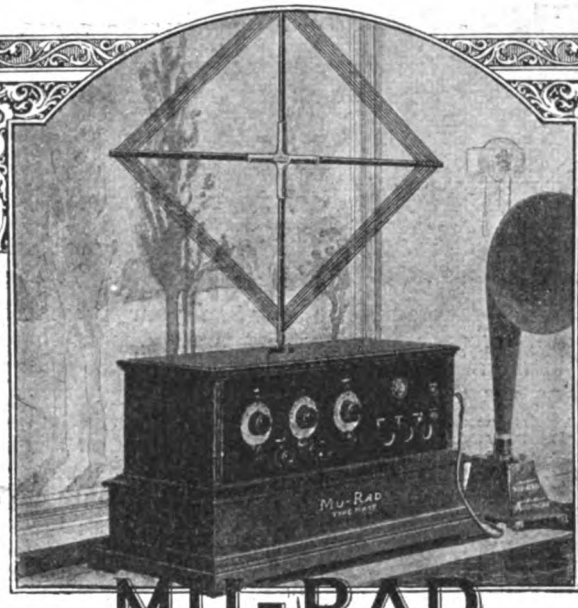

MU-RAD RECEIVERS

NEW MU-RAD RECEIVER MA-17

YEARS of scientific achievement anticipated in this *super set*, the MU-RAD MA-17. A new sensitivity, greater distance, fuller volume—with the absolute simplicity and substantial construction of the famous MU-RAD MA-13. Most recently discovered principles are embodied and the future thoughtfully considered in the designing of the MU-RAD MA-17.

Three stages of radio and two of audio frequency amplification and detector. *One* tuning dial and two selecting dials, each independent of the other. Plug-in type r. f. transformers to care for changes of tube type or wave lengths. Panel-mounted volt-meter for quick reading of A and B batteries. Solid mahogany, Adam Brown hand-rubbed finish cabinet with loop fitted into top and compartment in base for "B" batteries. Guaranteed for 1000 miles reception using only a 2-foot loop.

WRITE FOR BOOKLET AND THE NAME OF NEAREST DEALER

MU-RAD LABORATORIES, INC.

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Last Chance to Subscribe to Popular Radio at the Old Price!

Fill out the coupon below, and save from one to three dollars

IN its improved and enlarged form, POPULAR RADIO now sells for 25 cents on the newsstands. The addition of 56 more pages of reading matter beginning with the November issue, makes POPULAR RADIO the biggest value for the money that can be had in the radio magazine field.

And although the newsstand price has already advanced, the *subscription* price, for a few weeks longer, remains the same. Up to December 15th you can still subscribe to POPULAR RADIO at the old rate—only $2 for 12 big issues of 192 pages each. After December 15th, the price will be $3 a year.

Save Money by Acting Now

A year's subscription to POPULAR RADIO placed now, saves you a dollar over what you would pay later. **Or better still, you can now get TWO YEARS of POPULAR RADIO for only $3.** This special offer means a saving to you of $3. In other words, by acting now you may get two years of POPULAR RADIO at exactly **half** the price you would pay after December 15th.

To either **new** subscribers or **present** subscribers this same liberal offer is made. If you are already a subscriber, you may *extend* your present subscription for one or two years at these low rates, thus insuring yourself of all the helpful hints and practical suggestions, interesting articles, new hook-ups, and the wealth of timely information on all phases of radio which will appear in the pages of POPULAR RADIO during the months to come.

Mail the Coupon Today

Do not delay filling out and mailing the attached coupon. This offer is good only until December 15th, 1923. After that date all subscriptions to POPULAR RADIO will be at the rate of $3 a year. By taking advantage of this offer now, you save from one to three dollars.

And in addition, POPULAR RADIO itself—besides keeping you in touch with all the rapid developments in this fascinating field, will save you many times its cost when constructing and improving a set of your own, and will safeguard you against many an hour wasted in costly experiment.

Get only the *best* results with radio by becoming a regular subscriber to POPULAR RADIO. Fill out and mail the handy coupon today. This is absolutely your last chance!

(This offer holds good only until December 15th, 1923)

This Coupon Saves You $1.00 to $3.00

POPULAR RADIO, Dept. 125,
9 East 40th Street, New York City

Please enter (renew, or extend) my subscription to POPULAR RADIO for ONE YEAR at the present rate of only $2.00 a year. **This saves me a dollar** over what I would pay after December 15th. I enclose $2.00 (check, money order or registered mail).

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Address.....

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POPULAR RADIO, Dept. 125,
9 East 40th Street, New York City.

Please enter (renew, or extend) my subscription to POPULAR RADIO for TWO YEARS at the special low rate of only $3.00. **This saves me three dollars** over what I would pay after December 15th. I enclose $3.00 (check, money order or registered mail).

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Address.....

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(No extra for Canada. Foreign, ONE YEAR, $2.25: TWO YEARS, $3.50).

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The World's Standard Loud Speaker

You Never Tire of the Amplion

THE most striking thing about the Amplion is that its reproduction is never tiring. Its perfect rendition, absence of harshness gives you a thrill that is pleasing and refreshing.

No matter if it's voice or instrument, the charm is there. The message has lost nothing in its flight through space. It holds you and enthralls you just as if you were listening to the original.

The Amplion is made in several sizes to suit all occasions and pocket books from $18 for the Junior model to $66 for the Concert type

Ask your dealers to let you hear the Amplion. You owe it to yourself to hear the world's standard loud speaker before you buy.

Folder of styles and prices on request.

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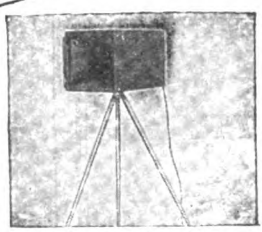
Amplion Beauty AR-15
$46.00

Phonograph Unit AR-35—**$24.00**

Amplion Dragon AR-19
$40.00

Amplion Junior DeLuxe AR-45
$26.00



Amplion Portable AR-61—**$50.00**

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$18.00

The Supremacy of the AMPLION is the Supremacy of Actual Performance

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RADIO LIGHTNING
ARRESTERS

$2.00 $2.00

Should be on every aerial the year 'round. Provides highly efficient lightning and static protection for the home. Fully approved by Fire Underwriters. Can be installed out-doors. Has no vacuum to lose. Install one in your aerial lead now—be safe.

This pioneer radio arrester is backed by 31 years experience in lightning arrester design.

For sale by Dealers everywhere, or sent post-paid for $2.00. Write for circular.

Electric Service Supplies Co.
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Philadelphia
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YOUR SET DESERVES A

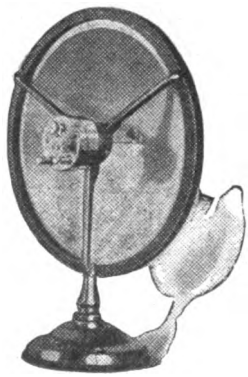
TURN-IT
GRID-LEAK
"ADJUSTABLE"

75c 75c

THIS IS FULL SIZE—AND SHOWS THE CONTACT PIECES IN POSITION FOR MAXIMUM RESISTANCE WHEN FULLY SUBMERGED IT HAS MINIMUM RESISTANCE. ALL INTERMEDIATE VALUES ARE OBTAINABLE. FITS ALL STANDARD MOUNTS

Charles E. Bonine
20 So. 15th St. Philadelphia

Long Distance



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THE NEW Pathé

LOUD SPEAKER

RULES SUPREME

Price $22.00

Pick up the Drake Hotel, Chicago, on any good set. Plug in a Pathe Loud Speaker. You'll get it as clear and loud as a local station. No speaker can compare with a Pathe for distant work. That's why thousands of Neutrodyne owners have bought a Pathe—the best at any price.

Every Pathe Loud Speaker is Guaranteed

PATHE PHONOGRAPH & RADIO CORP.
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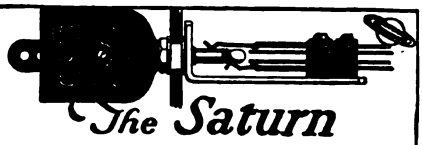
533 South Wabash Avenue, Chicago, Ill.



The Saturn

"Above the Ordinary" Radio Products

Automatic Plug

Terminal tips inserted, or removed in a moment. Perfect electrical connection without taking apart or soldering. Your satisfaction with the **Saturn Automatic Plug** unreservedly guaranteed. **$1**

Perfect Jack

A difficult soldering job made easy by crowfoot offset and solder-flex compound on blades. Brass brackets, nickel-plated, with rounded corners. Blades of spring German Silver. Solid silver contact points. Right in every detail.

List Prices

No. 1	Single Circuit, Open	50c
No. 2	" " closed	55c
No. 3	Double " "	70c
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Write for Folder

The SATURN Mfg. & Sales Co.
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C

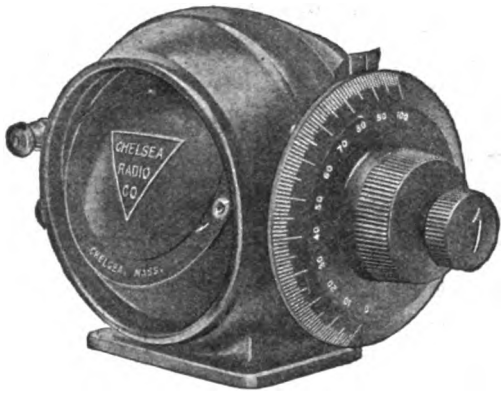
·NATIONAL·

CHELSEA

LEADERSHIP THRU QUALITY AND COMPLETE LINE

Get the Maximum Out of Your Receiving Set

Vernier Variometer No. 80 $8.00



Variocoupler No. 90 $8.00

BY USING

CHELSEA VARIOMETERS AND VARIOCOUPLERS

YOUR Set will tune sharper, thereby eliminating troublesome interference and will bring in stations you have never heard before.

ALL insulation is moulded bakelite. Great wavelength range—100–600 metres. No sliding contacts, therefore no objectionable noises. May be used for table or panel mounting. Variometer contains a *built-in* Vernier, an exclusive Chelsea feature.

Variocoupler contains individual binding posts for all taps.

Complete with Chelsea grade 3¼-inch dials.

Prices, $8.00

OTHER QUALITY CHELSEA RADIO EQUIPMENT:

Variable Condensers with Vernier	$4.25 to $6.75	Rheostats	$1.00 and $1.40
Variable Condensers	2.50 to 5.00	Tube Sockets	.50
Audio Transformers	3.75 and 4.50	Dials	.40, 45, 50

Write for our large catalogue, No. 3, which illustrates and describes the complete line of Chelsea Receiving Sets and Parts

NATIONAL CHELSEA RADIO CORP
739 Boylston St., Boston, Mass.

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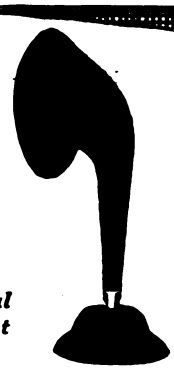
$8



A phone plus a FIBERTONE makes a beautiful musical instrument

The highest tonal quality undisturbed by either metallic noises or distortion is best obtainable with a fiber horn. This one factor is the reason for Fibertone's popularity. And the low price for such fineness is a sensation of the radio world. The beautiful crystalline finish of the Fibertone fits it for any place where the finer things of the home are seen.

If your dealer cannot supply you write direct.

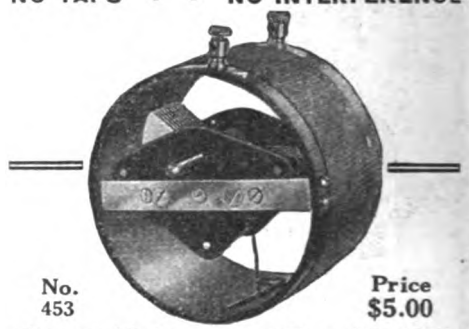
FIBER PRODUCTS COMPANY
34 Orange St. Bloomfield, N. J.

FIBERTONE
RADIO HORN

VERNI-TUNER
(Trade Mark)

3 in 1 ***Primary, Secondary and Variable Condenser***

NO TAPS - - NO INTERFERENCE



No. 453 **Price $5.00**

Indispensable for construction of Radio Sets

Just add a rheostat and socket and you have a complete regenerative set.

MOST SELECTIVE TUNER MADE

Saves Labor—Space—Money

Serves as the main tuning device for all regenerative circuits, reflex circuits and the Horne "Combined Tuned radio frequency and reflex" circuits.

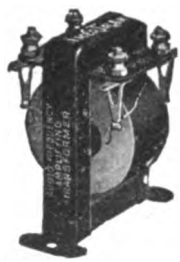
Other units for Reinartz, Cockaday, Flewelling and other circuits.

Booklet of 14 circuits free with each device.

At your dealer or postpaid on receipt of purchase price. Write for leaflet.

HORNE ELECTRIC & MFG. CO.
Mercer & Colgate Sts. Jersey City, N. J.

for
PURE TONE QUALITY
and MAXIMUM VOLUME



Price $7 Ask your dealer.

Or, sent carriage charges collect. (Wt. 1 lb.)

The AMERTRAN
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AUDIO TRANSFORMER

—recognized by the Radio Profession as the
STANDARD of EXCELLENCE

Turn ratio, 5:1. Amplification ratio, 30-40 times audibility in the flat part of the curve.

Send for Circular 1005

American Transformer Company
Designers and builders of radio transformers for over 22 years.
175 Emmet St., Newark, N. J.

ARMORCLAD FOR YOUR PROTECTION

Here is a tiny efficient instrument for controlling the filament temperature of U. V. 199 or similar tubes. It has a nichrome resistance unit, polished nickel finish, Bakelite knob and pointer, and is arranged for one hole panel mounting in a very small space.

THE MAR-CO 30 OHM ARMORCLAD RHEOSTAT

can be mounted on any radio frequency set in series with the potentiometer as a vernier adjustment and is worth its weight in gold as a critical control for regeneration.

LIST PRICE $1.00

MARTIN-COPELAND COMPANY
Providence, R. I., U. S. A.

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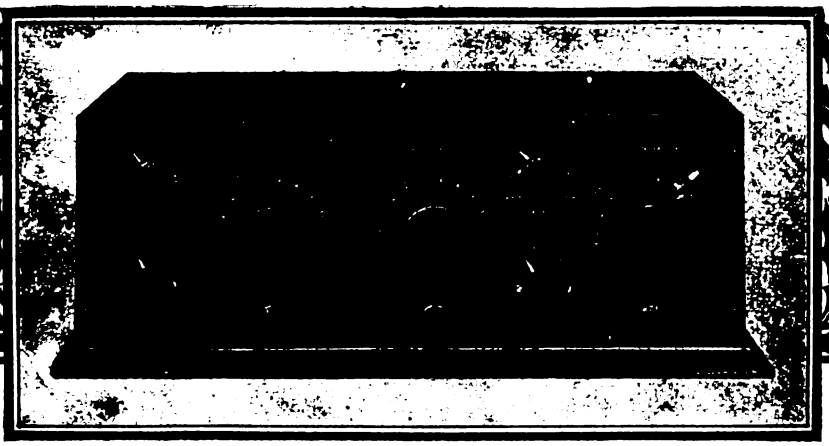

Type RB-2 **Price $135.00**

Announcing a *New Paragon Receiver* —the Ideal Family Christmas Gift

What could be a more wonderful Christmas gift than a radio receiving set that you *know* is the best money can buy? Think of the pleasure it will bring to every member of the family, young and old. Think of the happiness it will mean to you every night of the year.

PARAGON Radio Receivers are famous as the three circuit pioneers which have proved their superiority by eight years of practical operation.

The newest PARAGON, pictured above, is the last word in sensitivity and selectivity. The superiority of this type over all other classes of receiving equipment has been thoroughly proved by the long list of distance records which it holds. Included in these records are the reception of the first transcontinental amateur message, the reception of the first trans-Atlantic message, and the unbroken communication which it has maintained with the McMillan Expedition frozen in above the Arctic Circle.

The operation of the new PARAGON receiver is so materially simplified that even in the hands of a novice it equals in every way the performance of the older type in the hands of an expert.

All cabinet work is of mahogany with a brown mahogany finish. All metal parts showing, inside as well as outside of the cabinet are nickel plated. 98% of the wiring is invisible. The whole outfit is compact, neat, solidly built, and finely finished. It is the ideal Radio receiver and the ideal holiday gift.

An illustrated catalog of Paragon Radio Products is yours for the asking

Dealers: We believe in the proper distribution of Paragon Radio Products. Our Exclusive Distributors are particularly interested in territorially protected dealers, who will concentrate, solicit and serve the consumer in the sale of Paragon Radio Receivers. If interested, write us for details.

ADAMS-MORGAN CO., 20 Alvin Avenue, Upper Montclair, N. J.

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

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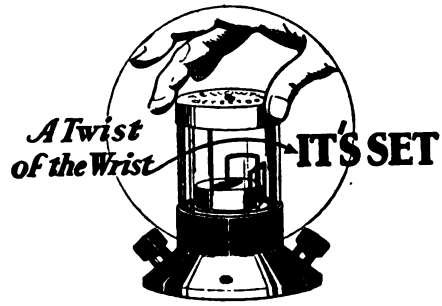
A Perfect Christmas Gift **$7.00**

At Your Dealer's or Direct
RADIOCEIVE MFG. CO.
NEWARK, N. J.

YELLOWTIP
MICROMETER ADJUSTING
CRYSTAL DETECTOR
INCREASES THE EFFICIENCY OF YOUR CRYSTAL SET

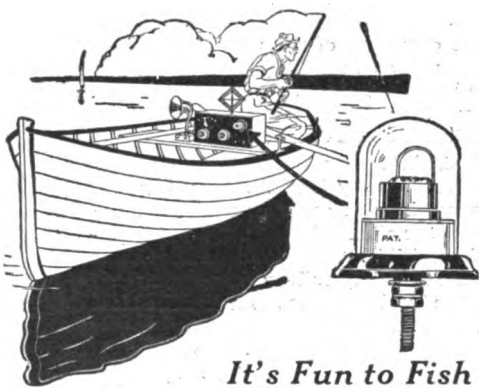


Any adjustment made in a moment—*fixed* instantly! Holds indefinitely, until you wish to change, then—"A Twist of the Wrist, It's Set." Ideal for reflex and other circuits. **$2**

Write for folder and name of your nearest dealer

Dealers and Jobbers—Write for Attractive Proposition

Wholesale Radio Equipment Company
Exclusive Factory Representatives
36 William Street **Newark, N. J.**



It's Fun to Fish
for Fish BUT—

fishing for a spot on your detector is no pleasure at all

THE GREWOL
FIXED DETECTOR

is *always* set and ready for use. No adjusting or replacements. The most satisfactory, always sensitive, guaranteed detector. At your dealer's or direct upon receipt of **$2**

Write for free booklet with new reflex hook-ups.

RANDEL WIRELESS COMPANY
4 Central Avenue, **Newark, N. J.**

HIGHEST QUALITY
SILVERTONE
Lowest Price
TUBES

TONE—like a silver bell.
VOLUME—unexcelled.
LIFE—2000 to 3000 hours
OPERATES—on dry cell or storage battery.

THREE MODELS

Voltage	2	3	5
Bat. consumption	.06	.15	.25

FULLY GUARANTEED

One Price **$6.00** Everywhere

Sold directly from factory to consumer, through our own agents—or by mail. Literature free on request.

Send no money—Pay the postman. Money back, without question, if not exactly as represented.

Manufactured by
DeForest Tel. & Tel. Co.
Exclusively for the
O. & T. Electric Corporation
1819 Broadway New York
High class representatives wanted.

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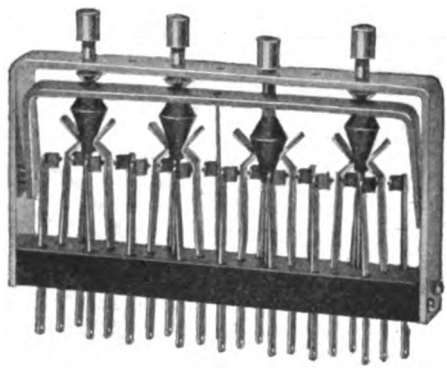
MEMBER RADIO SECTION

SE-AR-DE

MANUFACTURERS OF ELECTRICAL SUPPLIES

AUTOMATIC SELECTOR SWITCH



CATALOGUE No. 110 $6.50

The automatic selector switch is designed to do away with jacks and gives both phone and filament control. The phones or loud speaker remain permanently connected and it is only necessary to push the various buttons to shift from detector to one step or two steps or vice versa.

This switch is entirely automatic in its operation. It is built of first class material throughout, all springs are made from phosphor bronze, all contacts made of sterling silver.

We can make immediate shipments from stock

R. MITCHELL CO.

255 Atlantic Ave. **Boston, Mass.**

Pacific Coast Office: 709 Mission St., San Francisco **Export Office: 44 Whitehall St., New York**

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WARREN RADIO LOOP

Keep Your Set Small

A WARREN Radio Loop the most compact loop aerial, will fit inside your cabinet, under a table in almost any odd space. Remove the unsightly, dangerous, troublesome, old-fashioned outside antenna. A **Warren Radio Loop** simplifies, increases efficiency, and makes your set more useful.

Type A-737 (300-700 meters) 6 inches square—non-directional.....**$10**
Type A-7236 (175-1000 meters) 6 inches square—non-directional.....**$12**
Type B-2537 (300-700 meters) 18 inches square—directional.....**$20**
Type BL-2520 (200-18,000 meters) with honeycomb coil mounting. 18 inches square—directional.....**$25**

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.

resistant!

BDXX has higher dielectric strength than is ever required in radio.

Perfect for panels!

bakelite-dilecto!!

(A Laminated Phenolic-Condensation Material)

It is the only good insulator having amazing mechanical strength — yet readily machinable like metals.

Tough, durable, super-resistant. Resists water and solvents. Won't warp.

Ask any electrical man to get Bakelite-Dilecto (xx grade) cut to size for you.

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Dealer Service From:
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Pittsburgh, 301 Fifth Ave.
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San Francisco, 75 Fremont St.
Los Angeles, 411 S. Main St.
Seattle, 1041 Sixth Ave., S.

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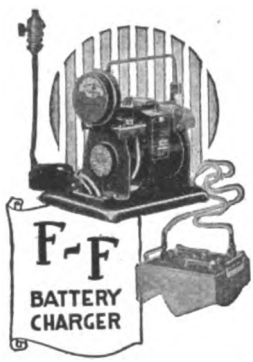
X

The Ideal Gift For Your Radio Friend



$15.00

F. O. B. Cleveland

Type 6 charges 6 Volt Storage Battery from any 110 Volt 60 Cycle lamp socket at average rate of 6 amperes, or over if battery needs it.

Scarcely a gift you could think of will bring more genuine appreciation than the satisfaction obtained from an F-F Battery Charger.

Buy from your dealer. If he cannot supply you, write for literature or enclose remittance covering express or postal charges on 9 lbs.

IT'S FREE—Write for Bulletin No. 44

The France Mfg. Co.
10444 Berea Road Cleveland, Ohio
Pioneer Manufacturers of Patented Battery Chargers

THE BULL DOG MAST SEAT

FILLS A LONG FELT WANT by enabling anyone to install a firm and rigid mast, on either a peaked or metal ridge roll type of roof, with ordinary tools found around the home, thereby eliminating customary trouble, labor and expense. Supplying neat, substantial construction throughout the entire aerial.

Seat for 1½" mast, hinged type.....**$3.00**
Seat for 1½" mast, peaked type, plain.....**2.50**
Seat for 1" mast, peaked type, plain.....**2.00**
Seat for 1½" mast, flat base.....**2.50**

Jobbers and distributers write for discounts.

MAST SEAT MFG. CO.
121 5TH ST. S. E.
MINNEAPOLIS MINN.

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The little button projects to warn, "I'm ON—don't forget me!" Saves both tubes and batteries.

The C-H Radio Switch can be installed on any panel in only a few minutes. Just one 7-16 inch hole is required. Large, convenient binding posts with cupped washers make wiring easy.

The heavy capacity of the C-H Radio Switch makes it suitable for a great number of radio control applications. Its perfect mechanism is the result of more than fifteen years' development by the famous C-H engineers, specialists in electrical control.

The Genuine Cutler-Hammer Radio Switch is sold only in the orange and blue carton, marked plainly with the C-H Trade mark. There is no substitute —even the Cutler-Hammer engineers could not build a switch to meet radio requirements and sell for less.

If You Use the New Tubes You *Certainly* Need This C-H Switch

There is No Filament Glare to Remind You When the Current is ON—The Little Nickeled Button Takes Its Place

There is no easier, safer way to protect *any* tubes than by placing a C-H Radio Switch directly in the "A" battery circuit. Then you can always be certain, when you push in the sparkling nickel button, that the current is *completely off* throughout the set.

But with the new tubes, this little convenience becomes a necessity. There is no filament glare to remind you, and unless a C-H Radio Switch button projects to say, "I'm *On*, don't forget me," you may easily do so at the cost of tubes and batteries.

See your dealer today. Have him show you the Radio Switch in the orange and blue box—and look for the C-H trade mark. Then you can be sure that it has the famous C-H wiping knife-blade contact that cleans itself and holds a perfect connection so as not to introduce microphonic noises when used in the most delicate circuits. It only takes a few minutes to install on any panel and adds hours of pleasure. If your dealer is not yet stocked, send 60c plus 10c for packing and you will be supplied promptly.

THE CUTLER-HAMMER MFG. CO.

Member Radio Section, Associated Manufacturers of Electrical Supplies

MILWAUKEE, WISCONSIN

C-H RADIO SWITCH

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A SUPER VERNIER RHEOSTAT

$3.00 AND WORTH IT

100% Efficiency from Your Tubes

There is no substitute for the Premier "Microstat"—no other instrument that gives such perfect control of the current delivered to the filament of radio tubes. New principle—two windings in parallel—one 6 ohm—other 40 ohm. Absolutely noiseless. Infinite control—handles any tube—Cap. 3 amp. Bakelite moulded—silver etched dial. Do not install a rheostat until you know all about the "Microstat." Our Bulletin No. 97 explains it in detail. Send for it. It's FREE.

Premier Electric Company

3807 Ravenswood Ave. Chicago

Ask your Dealer for PREMIER

"MICROSTAT"

TRADE MARK

B. T.

BREMER-TULLY UNIVERSAL-TUNER

$5.00

Gives

1. Vernier control hitherto unobtainable.
2. Unequalled results in single circuit regenerative Ultra Audion, etc.

Replaces

3. Tapped Reinarts Coils.

Highly

4. Selective and efficient for Reflex and R. F. Hookups.

Our new Booklet, "Better Tuning," will help you. It includes valuable information and new photo-diagrams. Sent on receipt of 10c—free with each tuner.

Bremer-Tully Mfg. Company

534 S. Canal St., - - Chicago, Ill.

LOUD SPEAKER $18.50

HEAD SET $4.50

"ROYALFONE"

KING OF ALL

A complete loud speaker of superior qualities. Will reproduce music or speech with no distortion.

No extra batteries required. Will operate at one or more stages of amplification.

Comes complete with 6 foot cord. 24" high—14" bell—Crystaline Finish.

Loud Speaker Unit with special phonograph attachment $8.00. Can be attached to any horn or phonograph arm.

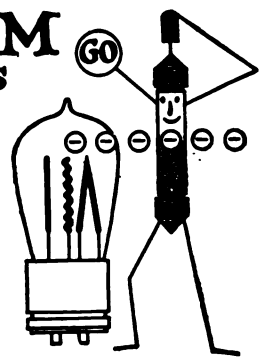
We are the makers of the "Royalfone" King of All headset at $4.50.

Royal Electrical Laboratories

Dept P. R., Newark, N. J.

Royalfone KING OF ALL

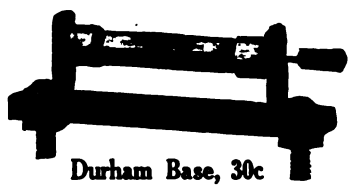
DURHAM Variables



High Resistance

No. 201 A

Special for UV201-A, C301, and WD12 tubes. Plunger control accurately variable from 2 to 10 megohms. Only 75c at dealers.



Durham Base, 30c

FREE folder tells how variable grid leaks work. Ask your dealer for copy

DURHAM & CO., Inc.

1930 Market St., Philadelphia

Dealers: When what you sell gets better results, the customer comes back — for more DURHAMS

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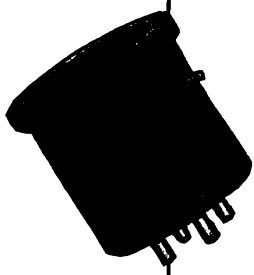
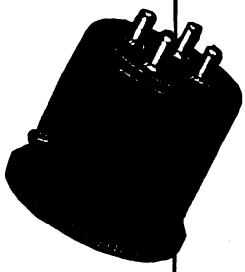
—JUST PLUG IT IN,

IT FITS A STANDARD SOCKET





An Adapter for UV-199 and C-299 Radiotrons which supplies the required resistance

It is no longer necessary to use an extra resistance coil, in series with low resistance rheostats—and the substitution of a high resistance rheostat is a needless expense.

The change to UV-199 and C-299 tubes may be made by simply connecting to a filament battery of proper voltage and inserting this combination Resistance-Adapter.

CONSTRUCTION DETAILS

(1) Contact at tube terminals is positive. Steel spring supplements tension of phosphor bronze contacts.

(2) Design of Spring and method of mounting contacts gives low distributed capacity.

(3) First quality insulation, moulded in one piece, reduces leakage to a minimum.

(4) Resistance element (18 ohms) is counter-sunk in a deep groove, assuring thorough protection from mechanical injury.

(5) Projecting knurled edge simplifies insertion and removal of Adapter.

(6) Like all other Eisemann Products, this unit will be found to be thoroughly efficient and high grade.

Ask Your Dealer For It

Price, $1.25

EISEMANN MAGNETO CORPORATION

William N. Shaw, *President*

BROOKLYN, N. Y.

Detroit Chicago San Francisco

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Revolutionary Construction Gives Increased Efficiency In

The BROCKWAY VARIABLE CONDENSER

There are only two spring bronze plates, separated by mica and scientifically formed to properly control the capacity curve. The result is elimination of high resistance and moving contacts, and reduction of radio frequency and di-electric losses. Beautifully finished genuine bakelite dial and base.

Easier to Adjust than a vernier. Two complete revolutions of dial (720 degrees movement) allow a wide range for fine adjustment, making accurate tuning easy and more stations possible.

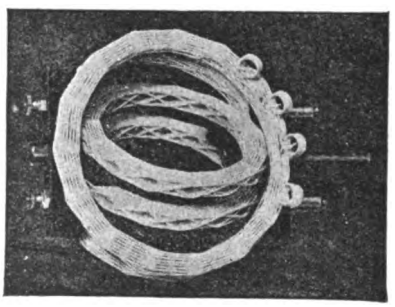
Saves Space Mounts entirely on front of panel, leaving more room behind for other instruments, tubes, B batteries, etc.

More Efficient in radio frequency, reflex, neutrodyne and other critical circuits. Improves any circuit requiring 11 to 43 plate condenser.

If your dealer has no Brockway Variable Condenser in stock, ask him to order for you; or we'll send postpaid on receipt of price with dealer's name and address.

Price $3.50

BROCKWAY LABORATORIES CO.
Factories Bldg., TOLEDO, OHIO



R. M. C. Diamond Weave Variocoupler and Variometer

Due to diamond weave construction and the fact that ⅛ of the total area of windings are supported in mid-air, capacity and dielectric losses are reduced to a minimum in R. M. C. Vari meters and Variocouplers. The rotor is continuously variable.

These products may be used in any circuit where a high grade coupler or variometer is required.

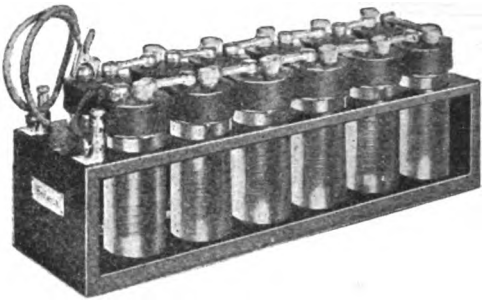
All metal parts are nickel-plated. Panel mounting requires very small space. Screw holes covered by 2" dial.

R. M. C. products are built for the finest sets that can be constructed.

Variocoupler **$4.25**
Variometer **$4.25**

Write for catalog of other diamond weave coils, and Radio Frequency Transformer.

THE RADIO MANUFACTURING COMPANY
of Springfield, Massachusetts
Dept. B **97 Dwight Street**



24 V SENECA $8.25 Post Paid RADIO "B" BATTERY

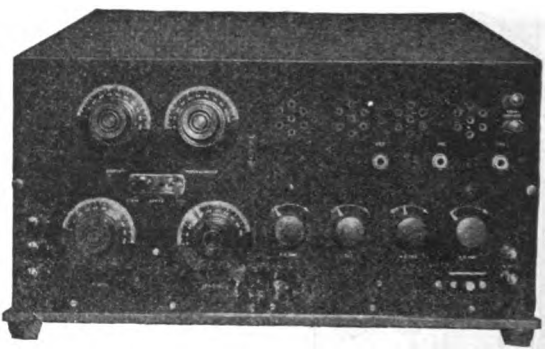
Absolutely Quiet *Dry* Charged

The Seneca 24 Volt Radio B Battery is designed and constructed for *long life, absolutely quiet and uninterrupted service*, its separate cell assembly prevents current leakage common to other types. Seneca Batteries are shipped DRY with FULLY CHARGED PLATES and are ready for service immediately after addition of acid, without initial charging. They guarantee successful RADIO OPERATION. Send for yours today, if not satisfactory, return in 30 Days and money refunded.

For those who wish to build their own B battery we offer Genuine Seneca Battery Parts at 50c each, consisting of one each Pos. and Neg. DRY CHARGED plates, one Separator, one Glass Jar, one Cover with Gasket and Vent, and one Cell Connector. Shipped via P. P. prepaid upon receipt of price.

SENECA BATTERY CORPORATION
1525 Main Street - - Buffalo, N. Y.

TYPE R-B-4



This is the set you have been looking for, and the one that you need.

Having one stage Radio Frequency, Tuned Impedance, Detector and Two Stages of Audio Frequency.

All apparatus mounted on panel 10 inches high, 21 inches long, and set in panel cabinet 10 x 21 x 10 inches deep.

Price $125.00 without tubes or batteries

WIRELESS ELECTRIC CO.
204 Stanwix St. **Pittsburgh, Pa.**

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How Lively Is Your "B" Battery?

THIS IS NUMBER THREE OF A SERIES

Some people buy Eveready "B" Batteries oftener than other people. This is because each fan has different tastes and desires in radio receiving. Those that demand maximum volume—and to get it use many tubes, forcing them to the limit with high voltages on the plates—are eager and frequent buyers of these batteries.

Others renew them less often. They are the ones that are content with smaller volume and employ fewer tubes at lower plate voltages.

Furthermore, every radio fan, regardless of the tubes he uses, has his own ideas as to when it is time to strengthen the signals with fresh "B" Batteries. Some will long enjoy concerts that others would not consider loud enough. Just what is "too weak" is purely a matter of personal opinion.

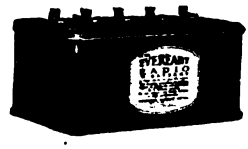
These, then, are the things that determine how long you use your "B" Batteries—

1. *The number and kind of tubes.* The more tubes you use and the greater their power, the more current flows from the "B" Battery and the shorter is its life.
2. *The "B" Battery voltage.* The higher it is, the more current flows from the battery.
3. *The amount of negative grid bias ("C" Battery voltage) on amplifiers.* The greater the bias, the smaller the "B" Battery current.
4. *The life put into the battery in the first place by the manufacturer, and the freshness of the battery when you buy it.*
5. *The signal strength you wish.* The smaller the volume of sound you can enjoy, the longer you can use your "B" Batteries.

The life of any "B" Battery you can buy is affected by the above factors. Subsequent advertisements will set forth each factor in detail.

Eveready "B" Batteries predominate. There is more life in them—*they last longer!* Blocks of large cells, packed with energy, made especially for radio use, delivered fresh to your dealer, give you the most power for your money—power you can use loudly and swiftly, or softly and slowly, as you wish—*Eveready for Everybody.*

"the life of your radio"



The Metal Case Eveready "B" Battery, No. 766. The popular 22½-volt Eveready Battery in a *new* handsome, durable, waterproof metal case. At all dealers, $3.00.

Eveready "B" Battery No. 767. Contains 30 large size cells, as used in the popular No. 766. Voltage, 45. Made especially for sets using detector and one or more stage of amplification. The most economical "B" Battery where 45 volts are required. At all dealers, $5.50.

Eveready Radio Battery No. 771. The Eveready "Three." The ideal "C" Battery. Voltage, 4½—three terminals permitting the use of 1½, 3, or 4½ volts. The correct use of this battery greatly prolongs the life of the "B" Battery. At all dealers, 70 cents.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, Inc.

Long Island City, N. Y.

EVEREADY
Radio Batteries
—they last longer

Note: This is Number 3 of a series of informative advertisements, printed to enable users to know how to get the most out of their receivers and batteries. If you have any battery problem, write to G. C. Furness, Manager Radio Division, National Carbon Company, Inc., 128 Thompson Avenue, Long Island City, N. Y. Write for special booklets on "A," "B," and "C" Batteries.

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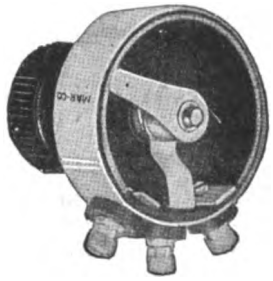
ARMORCLAD FOR YOUR PROTECTION



On the regulation of grid and plate circuit voltage depends the operation of a vacuum tube as detector, radio or audio frequency amplifier. This regulation is critical for greatest efficiency and for best results should be obtained while the tube is in operation through the use of a voltage regulator or potentiometer.

THE MAR-CO 600 OHM ARMORCLAD POTENTIOMETER

is altogether reliable for the purpose. It has a nichrome resistance unit so tightly wound that the turns cannot move under the action of the contact arm. Panel mounting requires only one drilled hole and the instrument is furnished with Bakelite Knob and Pointer and handsome polished nickel finish.

LIST PRICE $2.00

MARTIN-COPELAND COMPANY

Providence, R. I., U. S. A.

INSTRUMENT MAKERS

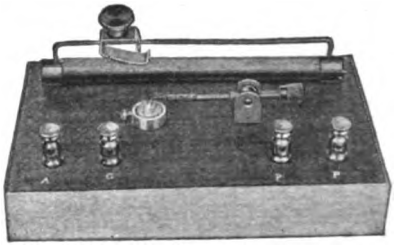
DEPENDABLE TESCO PRODUCTS

SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



FREE FAMOUS TESCO RADIO Crystal Set (Shown in Cut)

To introduce the wonderful T-B-H radio headset we will give absolutely free of charge, the most efficient crystal receiver on the market.

SEND NO MONEY

Just pay postman $5.00 plus postage. Money refunded if not absolutely satisfied.

THE EASTERN SPECIALTY CO.

3552 N. Fifth Street, PHILADELPHIA, PA.

HOWARD

HOWARD

No. 1001

6½ Ohm Rheostat..... $1.10
25 Ohm Rheostat..... 1.10
40 Ohm Rheostat..... 1.10
Patd. 870,042

HOWARD

No. 1002

6½ Ohm Micrometer Rheostat.... $1.50
25 Ohm Micrometer Rheostat..... 1.50
40 Ohm Micrometer Rheostat..... 1.50
Patd. July 10, 1923

Ask the man to show you the **Howard** line of quality Radio Merchandise. Every piece is sold with the **guarantee** of **satisfactory** performance.

Jobbers write for discounts.

HOWARD

No. 1003

200 Ohm Potentiometer.$1.50
400 Ohm Potentiometer .2.00
Patd. 870,042

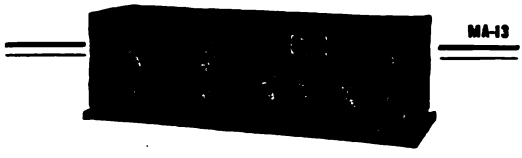
HOWARD

No. 1004

Multi Terminal Receiver Plug, instantaneous connection for as many as six pairs of standard receiver tips..... $2.00
Patd. Aug. 28, 1923

HOWARD RADIO CO., Inc.

4248 North Western Ave., Chicago, U. S. A.



80% of demonstrations result in sales for MU-RAD dealers.

When a complete check on the radio sales of one Chicago store reveals that Mu-Rad Receivers are sold in eight out of ten competitive demonstrations, there must be a reason.

There is! Mu-Rad is easy to operate, uses an inside 2-ft. loop aerial, and is highly selective. Mu-Rad is guaranteed to receive at least 1000 miles.

Dealers: Write for Mu-Rad proposition.

Inquiries are solicited from responsible dealers only.

In order to help us weed out curiosity seekers, please use your business stationery in requesting this imformation.

We also carry a complete stock of WESTERN ELECTRIC CO. GENERAL RADIO CO. parts. Write for details and discounts.

Chicago Radio Apparatus Co.

Jobbers of Good Radio Merchandise

General Offices: 407 S. Dearborn Street, Chicago

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THE SONOCHORDE
TRADE MARK

A comparative demonstration leaves no other Loud Speaker in the thoughts of those with whom performance is paramount.

Type C. With the 16 exclusive Sonochorde features. Mahogany or walnut cabinet. Complete with phone tip jacks, and swinging doors to vary volume $50.00

Other Sonochorde models

Type D, (illus.) $35.00

Type B 27.50

Type D

If your dealer cannot supply you, order direct

Correspondence with established distributors is invited

BOUDETTE MANUFACTURING CO., REVERE, MASS.

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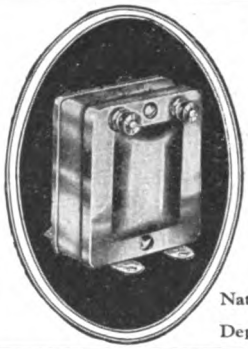


National Audio Frequency Transformers

The New 6 to 1 Ratio National Transformer is for use on the first stage of amplification. Its greater ratio means increased volume, b t the tone qualities that characterize the 3½ to 1 ratio have been fully retained. Price of 6 to 1 ratio $4.50 postpaid; of the 3½ to 1 ratio, $4.00 postpaid. *Dealers: Write for interesting sales proposition.*

National Transformer Mfg. Co.
154 Whiting Street
Dept. 1211 Chicago, Ill.

THAT NEW CRYSTAL THAT GIVES SUCH WONDERFUL RESULTS!

Entirely Different From Any Other Crystal on the Market. Surface Perfectly Smooth, and Supersensitive Everywhere.

CENTURY "RADIO REFLEX" Price $1.

Order from your dealer or direct from

CENTURY PRODUCTS COMPANY
110 So. 13th Street Allentown, Pa.

CATALOG

E19-100 PAGES FREE

EVERYTHING IN RADIO

One of the largest complete stocks in the world. 40 diagrams of latest Hookups.

DEALERS ALL OVER THE U.S.

Making big profits handling our supplies. 24-hour service. Goods shipped same day order received.

American RADIO Mfg. Co.

WHOLESALE RADIO DISTRIBUTORS
Dept. P 6 West 14th St. Kansas City, Mo.

LEARN RADIO

Here's your opportunity. Radio needs you. Win success in this fascinating field. Trained men in demand at highest salaries. Learn at home, in your spare time.

Be a Radio Expert

I will train you, quickly and easily, to design, construct, install, operate, repair, maintain, and sell all forms of Radio apparatus. My new methods are the most successful in existence. Learn to earn

$1,800 to $10,000 a Year

FREE Wonderful, home-construction, tube receiving set, of latest design. Write for "Radio Facts" free. Engineer Mohaupt.

American Electrical Association
Dept. 511 4513 Ravenswood Ave., Chicago

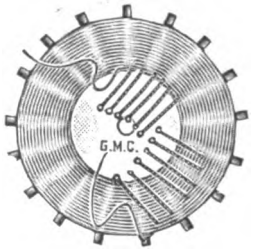
RADIO "B" BATTERY

DIRECT FROM FACTORY TO YOU
SHIPPED PREPAID

Greatest radio B battery on market. Absolutely fresh, full voltage, seamless cells, noiseless—will bring in Concerts **LOUDER** and **STRONGER!** Built correctly—full number of voltage taps—will work **any** tube or loud speaker. Real service **GUARANTEED.** Sold direct from our factories to you at lowest prices. Shipped prepaid to your door. ORDER TODAY. Send money order, check or pay C. O. D. Order By Number

No. 122B—22½ volt variable—regularly $2.25—our price **$1.98**
No. 122A—22½ volt variable—regularly $3.00—our price **$2.65**
No. 145A—45 volt—8 taps—regularly $6.00—our price **$4.98**

AYRES BATTERY CORPORATION, Cincinnati, Ohio



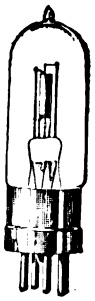
Order by Mail
Reinartz Coil

This coil for standard Reinartz circuit Green silk windings Special this month $1.75 post free

6 ohm Rheostat .75
30 ohm Rheostat .75

SEND FOR OUR FREE CATALOGUE NO. 10

ATWOOD ELECTRIC CO.
3122 W. Madison St. Dept. R. Chicago, Ill.



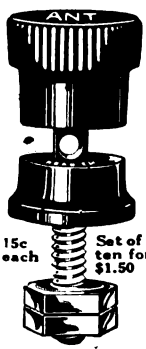
WE REPAIR
The Following
RADIO TUBES

WD-11	$3.50	UV-199	$3.50
WD-12	3.50	C-299	3.50
UV-200	2.75	UV-201A	3.50
UV-201	3.00	C-301A	3.50
C-300	2.75	UV-202	4.00
C-301	3.00	C-302	4.00
DV-6	3.00	DV-6A	3.50

Mail orders solicited and promptly attended to.

Dealers and Agents Write for Special Discount.

H. & H. RADIO COMPANY
Clinton Hill Sta. P. O. Box 22-E. Newark, N. J.



15c each

Set of ten for $1.50

"Read'em" Binding Posts

Simplify the most complicated hook-up

Tell at a glance whether it is Antenna, Ground, Fones, A or B battery, etc. Name neatly engraved *for keeps* on top of each post. (See illustration.)

Knobs Can't Come Off

The irremovable knobs save time, trouble and petty annoyances. "Read 'ems" add to the appearance of any set. Don't be without them. Price 15c each. Set of ten $1.50. If your dealer can't supply you with "Read 'ems" order direct.

Look for the name "Read 'em" on every post

The Marshall-Gerken Co.
Dept. J, 27 N. Ontario St., Toledo, Ohio

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"BUILD YOUR OWN" WITH "RASCO" PARTS!

THE Radio Specialty Company—"RASCO" for short—now in its third year, is unquestionably the oldest and most unique radio parts supply house in the United States, if not in the whole world. This Company makes a specialty of small orders. No order is too small to get immediate and prompt attention. The reason is simple: 80% of our orders are small.

The reputation of this house was built upon service. Ask any of your radio acquaintances what they think of "RASCO" service, "RASCO" promptness. Thousands of unsolicited testimonials are in our files, to prove that we serve the public as it has never been served in radio merchandise before. Be sure to get our great 84-page catalog, containing over 500 different parts. Catalog contains over 300 illustrations. "WE CAN ONLY DISAPPOINT YOU ONCE." Try us with a 50c. order and make us prove what we say. Prices include delivery to your door

Order direct from this page. We pay all transportation charges. All goods sent prepaid in 24 hours.

NOTE BIG PRICE REDUCTIONS THIS MONTH — **Money refunded if goods do not satisfy**

LOOP AERIAL

The loop aerial you have been waiting for. Made entirely of well seasoned hard wood. Complete with all parts and base; No. 22 enameled wire used. Total height of loop 36", 2 feet on the side; loop is 10 convolutions. Can be put together by anyone in less than 5 minutes. Satisfaction guaranteed.

R-2600. Two foot loop aerial, complete.....$1.15

STORAGE BATTERIES

New! New! New! Two volt, 40 ampere hour storage battery for use with WD11, 12, and U.V. 199 tubes. Don't keep on buying dry cells continuously. This storage battery will pay for itself in two months. Only best materials used. Guaranteed for 2 years. You can connect up to 6 dry cell tubes on a single one of these batteries. Can be recharged for a few cents. Hard rubber container encased in impregnated wood case. Due to low price and large weight of batteries, shipped express collect.

R-2400, Two volt, 40 ampere hour storage battery, size 2¾x8¾9".....$4.25
R-640, Six volt, 40 ampere hour storage battery, size 4¾x7¾x9".....8.75
R-660, Six volt, 60 ampere hour storage battery, size 6x7x9¼".....11.00

WOOD CABINETS

Highest grade mahogany cabinets made. Best hand rubbed finish. Top is hinged. Front of cabinet rabbetted to fit panel. Price delivered to your door; no panel included in these prices. Entire cabinet made of ¼" well seasoned stock.

R-714, Wood cabinets, panel size 7"x14"...$3.35
R-718, Wood cabinets, panel size 7"x18"... 3.60
R-724, Wood cabinets, panel size 7"x24"... 4.40
R-710, Wood cabinets, panel size 7"x10"... 2.60
R-712, Wood cabinets, panel size 7"x12"... 3.00
R-721, Wood cabinets, panel size 7"x21"... 3.90

CARDBOARD TUBING

Only seamless tubing made in United States. Perfectly seasoned Heavy wall. (I.D.—Inside Diameter. O.D.—Outside Diameter. L—Length).

R-6600, 2" I.D., 2¼" O.D. x 7" L.....$.30
R-6601, 2½" I.D., 2¾" O.D. x 7" L..... .35
R-6602, 3¼" I.D., 3½" O.D. x 5" L..... .25
R-6603, 3¾" I.D., 4" O.D. x 5" L..... .27
R-6604, 4" I.D., 4¼" O.D. x 7" L..... .35
R-6605, 2¾" I.D., 3" O.D. x 2¾" L..... .15

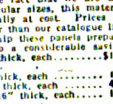
"RASCO" BEZELS

The finest Bezel on the market. Best brass mesh used. The bezel comes entirely nickle plated. Will improve looks of your panel 100 per cent. Outside diameter 11". Can be used on ⅛" or 3-16" panel.

R-1700, Rasco bezel.....$.15
R-1701, Bezel 1½" diam.... .20

FORMICA PANELS

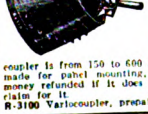
Clearance Sale.



This sheeting is positively the best grade on the market. High Finish on both sides. Too well known to require much explanation. Due to the fact that we are discontinuing these particular sizes, this material is now offered practically at cost. Prices are about 40 per cent lower than our catalogue list. Note also that we ship these panels prepaid. This alone amounts to a considerable saving.

R-350, 6"x12"x3-16" thick, each.....$1.50
R-352, 9"x12"x3-16" thick, each..... 1.75
R-353, 12"x18"x3-16" thick, each..... 4.00
R-354, 6¾"x19½"x3-16" thick, each..... 1.90
R-356, 6"x14"x3-16" thick, each..... 1.60
R-357, 6"x4"x3-16" thick, each..... .65

RASCO 180° VARIOCOUPLER



This Coupler while extremely low in price will do anything and everything that the more expensive ones accomplish. Silk Wire wound on bakelite tubes. There are six taps. Wave length of coupler is from 150 to 600 meters. Coupler is made for panel mounting, ¼" shaft. Your money refunded if it does not do all that we claim for it.

R-3100 Variocoupler, prepaid.....$1.50

MELOTONE LOUD SPEAKER

The best popular loud speaker on the market. Has tuned feature the same as all "Rico" phones. Fibre horn, heavy metal base, fire foot cord. Nickle gooseneck. Greatest tuned loud talker. Compares favorably with most expensive speakers. Size overall 14⅛"; horn length 11½"; bell 6¾"; total height 9".

R-255, Melotone Speaker.....$4.90

RICO TUNED RECEIVERS

No better phones made. Supersensitive. Awarded Radio News Laboratories Certificate of Merit. The only tuned phone on the market. Can be tuned for any intensity and sensitivity. Magnetic pole of phone is in mathematical center of diaphragm. Turn the cap to tune.

R-2020, 2000 ohms, double head set.....$4.45
R-3030, 3000 ohms, double head set.....$5.50

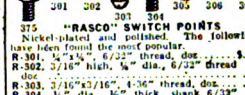
"RASCO" VERNIER

Cleverest vernier made. Can be used with any dial. Soft rubber ring engages dial. Does away with vernier condenser. We guarantee results. All metal parts moulded in best black composition. Nothing to come apart. Biggest hit of the season.

R-1450, Vernier.....$.30

"RASCO" POSTS

R-650, Post made entirely of best black composition—8/32" screw—each.....$.08
R-202, Post has nickel-plated bottom part, each.....
Dozen, each style.....



"RASCO" SWITCH POINTS

375

Nickel-plated and polished. The following have been found the most popular.

R-301, 1"x¼", 6/32" thread, doz.....$.18
R-302, 3/16" high, ⅜" dia., 6/32" thread doz.....
R-303, 3/16"x3/16", 4-36" thread, doz.....
R-304, ⅜" dia., ⅛" thick, shank 6/32" doz.....
R-305, ⅜" dia., 3/16" thick; shank 4/36", doz.....
R-306, 3/16" dia., 3/16" thick, shank 4/36 doz.....
R-307, 3/16" dia., ⅜" thick; shank 4/36, doz.....
R-375, Switch Stop, ⅝" long, 4/36 thread, complete with nut, each.....

"RASCO" SOCKETTES

Substitute for Vacuum Tube Socket Four of these take one Vacuum Tube. Grasp tube firmly. Best contact possible. Take less room. Are better.

R-1550, Sockettes, nickeled, set of 4.....$.25
R-1551 Sockettes, nickeled, set of 4 (to take WD-11 Tube).....
Note: Set of 4 sufficient to hold 1 Tube

COPPER FOIL

Thinnest copper foil made, .001" thick. Comes 4" wide.

R-5025, Copper Foil, per ft. $.10
10-ft. length.....80

PHONEHORN

Fills a new and distinct want. Base consists of R-1310 Phonedapter described on this page into which fits a fine enameled fibre horn. Size of horn 12"; bell 6½". Slip Phonedapter end on a single telephone receiver and you have the lowest priced loud talker ever made. Mounted in your set or hung in corner of room it will bring sound all over the room. A most useful article. Welcome by all radio fans. R-1321 Phonehorn, prepaid.....$1.45

AUDIO FREQUENCY TRANSFORMERS

No better Transformer on the market. Highest class materials. Impregnated coils. Silicon steel stampings used. Save 50 per cent by assembling it yourself.

R-1100, A.F. Transformer, ratio 4½ to 1.....$2.00
R-1150, A.F. Transformer, ratio 6½ to 1.....$2.00

RADIO FREQUENCY TRANSFORMERS

The best Radio Frequency Transformer developed so far. Designed for us by Mr. R. K. Lacault, Associate Editor of RADIO NEWS. Air core. Guaranteed to do the work. This Transformer brings in the long distances.

R-2800 Radio Frequency Transformer, size 1⅝"x2½".....$1.50

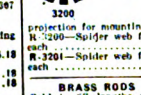
RHEOSTATS AND POTENTIOMETERS

Highest grade Rheostat made. High heat dielectric composition base. Wound with best non-corrosive resistance wire. Comes with lateral, knurled knob. Diameter, 2¼". Complete with pointer.

R-4310—6 ohm, each $.45
R-4311—30 ohms, for 201a tubes, each.....$.65
R-4412—Potentiometer, 200 Ohms each..$.85

JUST OUT Cat. No. 10

SPIDER WEB FORMS



At last! Fine forms to wind your spider webs. Made from hard, well seasoned fibre, 1-16" thick, center and side holes for winding. 3200 has 13 slots, 3201, 11 slots, both 5" diameter. 3201 has projection for mounting.

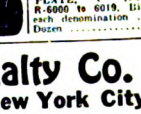
R-3200—Spider web form, each.....$.25
R-3201—Spider web form, each.....$.25

BRASS RODS

Sold in 6" lengths only

R-8032, Brass Rod, 8/32" thread, per length.....$.08
R-6032, Brass Rod, 6/32" thread, per length.....
R-1425, Brass Rod, plain ⅛" round, per length.....
R-3616 Brass Rod, plain 3/16" round, per length.....

"RASCO" NAME PLATES



The circular plate is our new Binding Post Name Plate. Diameter, 1½". Terminals: PHONES, GROUND, — OUTPUT, "A" BATTERY —, "B" BATTERY —, LOUD SPEAKER, GRID, LOAD, "C" BATTERY—AERIAL, +, ANTENNA, "A" BATTERY +, LOOP, TICKLER, "B" BATT +, FILAMENT +, PLATE, "C" BATT +.

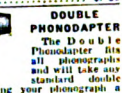
R-6000 each 6019, Binding Post Name Plates, each denomination.....$.01
Dozen.....

PHONEDAPTER

The Phonedapter will fit any phone. Metal tube fits any standard phonograph. Make your phonograph a loud talker. Fits Columbia, Victor and Sonora phonographs. Is made entirely of pure soft rubber with brass tube inserted.

R-1310 Phonedapter.....$. 50

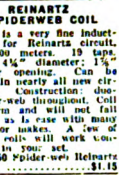
DOUBLE PHONEDAPTER



The Double Phonedapter fits all phonographs and will take any standard double head set, thereby making your phonograph a loud talker. Made of cast metal, nickel plated and highly polished. Has three generous soft rubber bushings.

R-1320 Double Phonedapter.....$. 65

REINARTZ SPIDERWEB COIL



Here is a very fine inductance for Reinartz circuit, 200-600 meters. 19 taps. Size 4¼" diameter; 1¾" center opening. Can be used in nearly all new circuits. Construction: duo-spider-web throughout. Coil is firm and will not fall apart as is case with many inferior makes. A few of these coils will work wonders in your set.

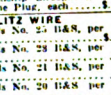
P-2550 Spider-web Reinartz coil.....$1.15

PLUGS

RASCO Telephone Plug. This is the plug that is sold from 75c. to $1.00 everywhere. Has hard rubber composition shell and patented cord tip holder. Must be seen to be appreciated. Finest workmanship throughout.

R-1030—Rasco Telephone Plug, each.....$.35

LITZ WIRE



R-323, equals No. 24 B&S, per foot.....$.02
R-890, equals No. 28 B&S, per foot......01
R-891, equals No. 21 B&S, per foot......03
R-892, equals No. 20 B&S per foot......04

Prices of 10 percent in 100-ft. lots.

UNIVERSAL BEARING

THE bearing to hold variometer and variocoupler rotors. Total length over all, 2¾". Outside shaft, 1¼". Length of thread 1". Length of threaded sleeve, ⅝".

R-1375, Bearing.....$.25

PANEL MOUNTING VARIABLE CONDENSERS

The condenser presents the latest word in precision mechanics. Plates, washers and all other parts are accurately machined. Positively no better condenser on the market. Shafts ¼". Save from 10% to 60% by assembling condenser yourself. A child can do it in a few minutes spare time. Capacities guaranteed.

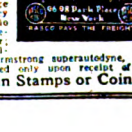
R-1111 11 plate condenser, .00025 mfd....$1.10
R-2121 21 plate condenser, .0005 mfd..... 1.22
R-4343 43 plate condenser, .001 mfd..... 1.50

The "Rasco" Catalog

CONTAINS 75 VACUUM TUBE HOOK-UPS. 350 ILLUSTRATIONS No. 10
350 ARTICLES. 84 PAGES

All Armstrong Circuits: These important circuits are explained clearly, all values having been given leaving out nothing that could puzzle you.

Just to name a few of the Vacuum Tube circuits. The XT as a detector and one-step amplifier; Armstrong circuits; one-step radio frequency amplifier and detector; three stage audio-frequency amplifier, short wave regenerative circuits; 4-stage radio frequency amplifiers; radio and audio frequency amplifier; inductively coupled amplifier; Armstrong superautodyne, etc.



Catalog mailed only upon receipt of 15 Cents in Stamps or Coin.

Radio Specialty Co.

96A Park Place - New York City

Oldest and Original Exclusive Radio Parts House in U. S.

Factories: Brooklyn, N. Y. Elkridge, Md.

DEALERS Get Our Special Proposition

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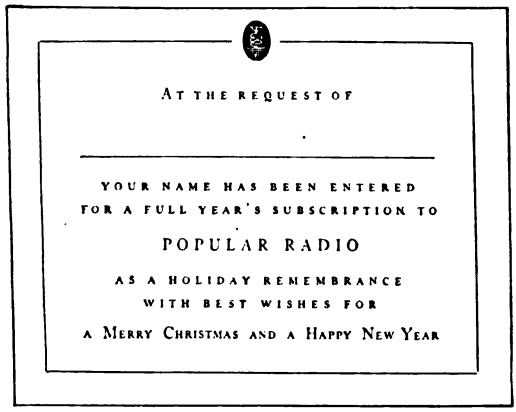
AT THE REQUEST OF
YOUR NAME HAS BEEN ENTERED
FOR A FULL YEAR'S SUBSCRIPTION TO
POPULAR RADIO
AS A HOLIDAY REMEMBRANCE
WITH BEST WISHES FOR
A MERRY CHRISTMAS AND A HAPPY NEW YEAR

This Christmas Greeting Card will reach your friend on Christmas morning.

Could any gift be more heartily appreciated than 12 months of POPULAR RADIO?

Let POPULAR RADIO Solve Your Christmas Problems for You

A GIFT that will be truly appreciated by any radio enthusiast! A year's subscription to POPULAR RADIO. And you need not pay for it until later, unless you prefer.

The illustration shown above is a small facsimile of a beautiful colored Christmas Card which POPULAR RADIO will mail for you to any friend you select. The card will reach your friend on Christmas morning, telling him that you are the generous donor of a year's subscription to POPULAR RADIO.

With this Christmas Greeting Card will go the first copy of POPULAR RADIO applying on this gift subscription. Both the card and magazine will reach your friend on Christmas morning. And every month thereafter *for a year* your friend will receive his copies of POPULAR RADIO—a twelve-time reminder of you and your Christmas remembrance.

Could any gift be more appropriate for your friends who are interested in radio than a year's subscription to POPULAR RADIO? And if some friend that you would like to remember at Christmas time already happens to be a subscriber to POPULAR RADIO what gift would be more appreciated by him than a *renewal* or a year's *extension* of his subscription?

All that is necessary for you to do is to fill out the handy coupon below, indicating your own name and address, also the name and address of the friend to whom you wish us to send the Christmas Card and POPULAR RADIO. We will do the rest. Send no money. We will gladly bill you later for the small amount of $2.

When your friend receives his Christmas gift of a year's subscription to POPULAR RADIO, it will be a $3 magazine. Your friend receives, therefore, a $3 Christmas remembrance from you. But you pay only $2 because up to December 15th you can place this subscription at the old rate. And you do not pay a penny now. We will simply send you a bill for the $2 later on.

"Do your Christmas shopping early." Send the coupon today, and one or more of your Christmas problems will be solved!

(This coupon must be mailed before midnight, December 15th)

POPULAR RADIO, Dept. 127,
9 East 40th Street, New York City

I am very glad to avail myself of your special Christmas offer. Please send (so as to arrive on Christmas morning) a copy of January POPULAR RADIO to the address shown on the right. Also send a Christmas Greeting Card, announcing that the gift of a year's subscription is from me. Bill me later for $2.

My Name.....

My Address.....

.....

Here is the name and address of my friend whom I wish to remember at Christmas time with a year's subscription to POPULAR RADIO.

Friend's Name.....

Address.....

.....

NOTE: If you wish to remember several friends in this appropriate way, simply write their names and addresses on a sheet of paper and mail with this coupon to POPULAR RADIO.

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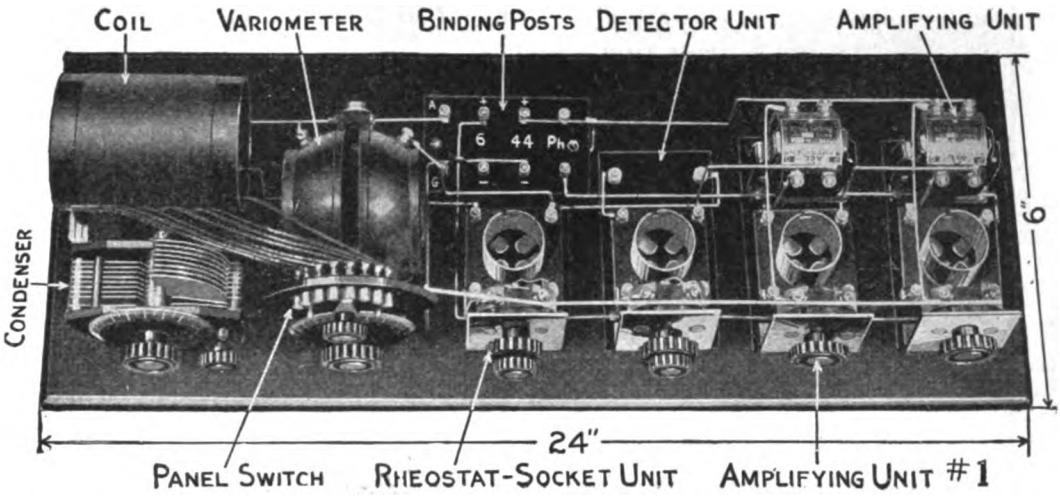


Tuned Wave Trap Radio Frequency Receiver

1 Stage Radio-frequency—2 Stages Audio-frequency
Built on Famous Copp Circuit No. 4
Efficient for all wave-lengths from 200 to 700 meters
Range up to 2000 miles

Any amateur can build the above set with A-C DAYTON Complete Units

$43.35

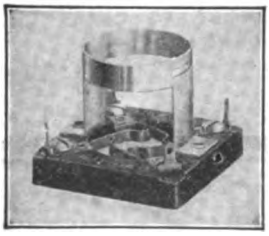
Units packed complete in one carton with wiring diagrams, photographs, instructions, etc., for complete installation.

SEE YOUR DEALER OR WRITE US DIRECT

THE A-C ELECTRICAL MFG. CO., Dayton, Ohio

Makers of Electrical Devices for over 20 Years.

A Socket of Exceptional Merit



Specifications

1. Contact springs and wire terminals of one piece heavy phosphor bronze.
2. Convenient screw terminals of large dimensions.
3. Handy soldering terminals.
4. Skeleton sleeve allows for inspection of tube contacts without removal of socket.
5. Base, high grade moulded insulation 2⅛ inches square.
6. All metal parts highly polished and heavy nickel plated.

At your Dealer's or by mail on receipt of purchase price

Price 50c

WEIN SALES CORP., 254 Park Ave., Brooklyn, N. Y.

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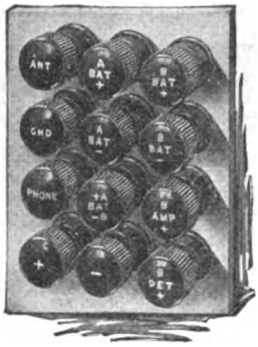

A set of EBY ENGRAVED POSTS

will make him happy on Christmas morning. Your boy or his pal will appreciate this useful gift because it will give him lasting satisfaction.

For sale by Dealers everywhere

The H. H. Eby Manufacturing Co.
Philadelphia, Pa.

THE NEW SIMPLEX

180° Vario-Coupler with Special Spider Web Rotor will bring in those distant stations you are trying for. An exceedingly efficient and neat coupling device which will cover all broadcast wave lengths up to 600 meters.

Price - - $3.50

SIMPLEX RADIO CO.
1013-15 Ridge Ave. Phila., Pa.

Announcing **DX-ALENA** Announcing

The Powerful Long-Distance Crystal

DX-ALENA is a phenomenal, all-sensitive, synthetic crystal that positively outclasses all others. DX-ALENA is broadcast tested and guaranteed absolutely without an equal for loudspeaking and long-distance reception. Fans report extraordinary success with DX-ALENA. Order one of these wonderful crystals today for your crystal or reflex set. By mail 50 cents. DX-ALENA is made by The Chemical Research Co.

Dealers and Jobbers write for prices.

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Radio Equipment of Quality
5207 Dorchester Ave. Chicago, Ill.

$2.50 Republic Audio Frequency Transformer

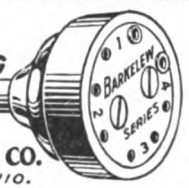
(FOR ALL TUBES)

GUARANTEED

Mail Orders Filled Promptly

FLINT RADIO CO.
1770 Wilson Ave.
CHICAGO, ILL.

BARKELEW FOUR-PHONE PLUG for STANDARD JACKS



The BARKELEW ELEC. MFG. CO.
MIDDLETOWN, OHIO.

TU-WAY PLUG $1.00

Takes 1-4 head-sets. Does more for a dollar than any other plug, and does it better. Catalogue free.

Carter Radio Co.
1807 Republic Bldg. CHICAGO

MAKE YOUR OWN **RADIO RECEIVING SET**

ENJOY the concerts, market reports, latest news, etc., as sent out by large broadcasting stations. This NEW copyright book, "EFFICIENT RADIO SETS," shows how to make INEXPENSIVE set for receiving wireless broadcastings. Sent postpaid for 25c. Address J. C. Dorn, Pub., 725 S. Dearborn St., Dept. 110, Chicago.

You Don't Need Tubes

to get out of town. If you want new stations on your crystal set WRITE ME TODAY. Mine works 400 to 1,000 miles without tubes or batteries! Thousands have bought my plans and now get results like mine. CHANGES OFTEN COST LESS THAN A DOLLAR. Send self-addressed envelope for further information. **Leon Lambert, 540 South Volutsia, Wichita, Kansas.**

Let Radio Experts Buy for You

This Service Is Free

Why hunt from store to store? Save time, trouble and money—a group of Radio Experts in New York will act as your *personal representative*, buy for you any standard make of radio equipment you want, from the smallest part to a complete set, either assembled or unassembled, and deliver it to you prepaid—all for less than if you did your own buying. Satisfaction guaranteed. Advice on all radio problems—free to our clients. Write for plan.

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PALL MALL PRODUCTS

HOOK UP AND DESCRIPTION of the famous ESSEX ONE TUBE COAST TO COAST CIRCUIT

—FREE—

To the first 5000 fans who send in a 2c stamp and the names and addresses of five friends who are interested in Radio.

ESSEX MFG. CO., 115 Mulberry St., Newark, N. J.

FOR EASY MOUNTING FRAMINGHAM DE LUXE PARTS

Ask Your Dealer

2650 MILES

with ONE TUBE. Broadcasting from Atlantic Coast and Cuba heard in California by users of the CROSS COUNTRY CIRCUIT. This range is due to simplicity of set and operation as only one control is used for tuning. Easily and cheaply built. Dry cell tubes may be used. Complete instructions, with panel layout, assembly views, etc., postpaid for 25c. Or further information for red stamp.

VESCO RADIO SHOP, Bx. PR-117, Oakland, Cal.

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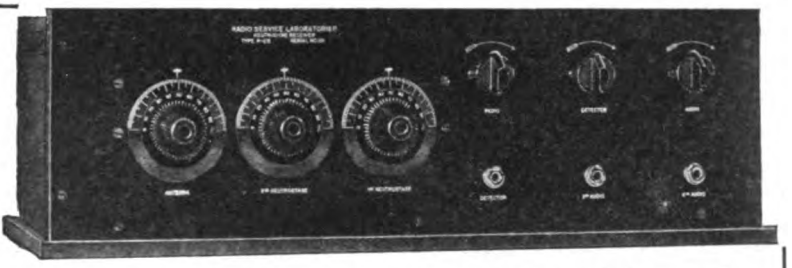
"The Best Built Set in America" R-212



RADIO SERVICE LABORATORIES

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Embodying the Hazeltine Neutrodyne circuit in an improved form as to neutralization, workmanship, quality, appearance and efficiency of operation.

Radio Service Laboratories, 1000 11th Ave. Asbury Park, N. J.

DEALERS!

We handle only well known and nationally advertised lines. On top of that we give the kind of service you expect.

And—Our discounts are RIGHT.

Drop us a post card for our 36-page catalog just off the press.

Wholesale Radio Distributors

Address Dept. 10

WERNES & PATCH

159 N. STATE ST. CHICAGO, Ill.

IMPROVED RECEPTION

with

THE PRECISION COIL

This coil is made according to the specifications of Laurence M. Cockaday.

These include

1. Better Wire
2. Better Insulation
3. Better Tubing
4. Better Terminals
5. Better Design

In short, BETTER EFFICIENCY than has heretofore been attainable.

Write us about these coils

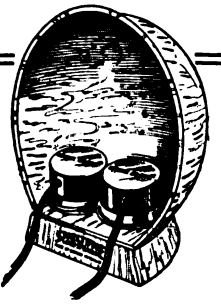
Mail orders filled promptly.

Special Dealer Proposition

PRECISION COIL CO., INC.

Flushing, N. Y.

SHELTONE LOUD SPEAKER



This NEW Pyralin-SHELTONE, made by DUPONT, gives greater volume—better tone and is more beautiful in appearance.

AT ALL DEALERS

Use the SHELTONE with ANY good phones and get wonderful results. We are distributors for Nath. Baldwin phones and the new Baldwin Loud Speaker.

THE SHELTONE CO.

185-189 Clinton Ave., Newark, N. J. ***Discount to Dealers***

$3.00

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Sweeping the Nation!

1,000 MILE RECEPTION

$39 and Up

The Lytton line of radio masterpieces is now being demonstrated by a number of unsolicited dealers. Mark us! When our broad campaign is announced in a short time, it will start a new era in radio.

Write for catalog. Specify which set interests you.

Lytton Radio
TRADE MARK PAT. PENDING

WALTER LYTTON, INC.
CHICAGO
LYTTON BLDG.

ALSO "COAST-TO-COAST" Loop set with the Lytton 4-tube "Duplex" circuit $112.50

Cold Winter Nights

Won't find you on the roof fixing the aerial—removing snow and sleet, exposing yourself to sickness, if you use

ANTENELLA

(No aerial or antenna needed.)

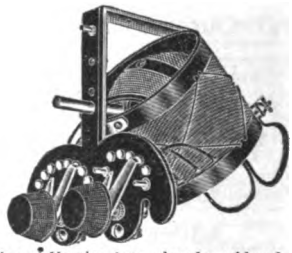
A light socket plug that eliminates all outside wiring, lightning arresters and other inconveniences. Merely plug Antenella in any light socket and you can enjoy the best in radio in any room in the house.

Now Only $1.25

At your dealers—otherwise send purchase price and you will be supplied without further charge.

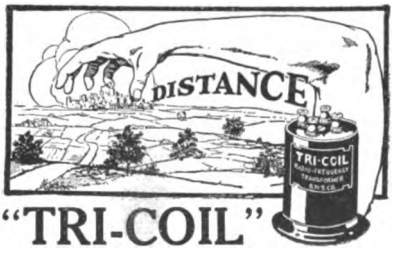
Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Ave., New York

E-Z-ON SELECTOR



Both rough and Vernier taps already soldered. Only two extra holes to drill. Drill template furnished. Sharpest tuning. Guaranteed, $8.50

UTILITY ELECTRICAL PRODUCTS CO.
2738 Van Buren St., Chicago, Ill.



"TRI-COIL"

The Transformer with the Compensating Coil

Meets All Requirements

"Tri-Coil" covers all wave lengths and assures perfect amplification.

"Tri-Coil" is excellent in standard radio frequency circuits.

"Tri-Coil" is scientifically designed to conform with the individual characteristics of the various tubes on the market.

"Tri-Coil" Type A is for use with U. V. 201A or C301A tubes.

"Tri-Coil" Type 9 is for use with U. V. 199-C299 W. D. 11 or 12 tubes.

Only $2.00

At your dealers—otherwise by mail postpaid on receipt of purchase price.

Free illustrated drawing of one tube "Tri-Coil" Reflex Circuit, which will operate loudspeaker, on request.

BROOKLYN METAL STAMPING CO.
718-28 Atlantic Avenue, Brooklyn, New York

RADIO TUBE EXCHANGE

We Repair All Standard Makes of Tubes Including

W. D. 11 or W. D. 12	$3.50
U. V. 200 or C. 300	$2.75
U. V. 201 or C. 301	$3.00
U. V. 201A or C. 301A	$3.50
U. V. 199 or C. 299	$3.50
U. V. 202 or C. 302	$3.50
New 1½ Volt Tubes	$4.00

All tubes guaranteed to do the work.

RADIO TUBE EXCHANGE
200 BROADWAY DEPT. 3 NEW YORK CITY
All Mail Orders Given Prompt Attention
Orders sent Parcel Post C. O. D.

FOR CLEARER SIGNALS
FRAMINGHAM
DE LUXE PARTS
Ask Your Dealer

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The Improved **MIRACO** **Gets 'em from Coast to Coast**

Clearly and distinctly, too! For our users tell us that Cincinnati hears Frisco, Denver hears Schenectady, New York hears Havana! Scores of long distance records were made on these instruments last year so with the many new refinements incorporated the result obtained now will be far better than ever.

Highest Quality at Lowest Price

This has always been the MIRACO key-note and the thousands of sets now in use are a fitting tribute to MIRACO'S excellent performance. Many new improvements, such as new sockets resting on shock absorbing pads—a refinement found only in the most expensive sets—rheostats with multiple resistance windings, making it possible to use either dry cell or storage battery tubes, and a new aluminum shield that prevents annoying body capacity effects, are embodied.

Cabinet is of solid mahogany—workmanship the finest—operation extremely simple yet always dependable.

2 tube outfit shown above.....$29.50
1 tube outfit.....18.50
4 tube outfit shown below.....54.50

Write for our new bulletin today.

Dealers — Jobbers

Write for our proposition quickly.

Agents!

There's still some territory open—write or wire.

THE MIDWEST RADIO COMPANY, 812 Main Street, Cincinnati, Ohio

IF YOU CAN'T BUY THEM AT YOUR DEALER'S SEND DIRECT TO US

"Red-Heads" are *guaranteed* radio phones. You run no risk when you buy them. Money back if, after 7 days' trial, you're not satisfied that they're the *best* receivers on the market at the price. Why not act *right now* and get a pair? It'll mean getting the *maximum* from broadcasting from the day you put them into use.

RED-HEAD RADIO RECEIVERS

These remarkable head-sets are made by The Newman-Stern Co., one of the *pioneer* radio manufacturing houses in America.

JUST OUT

The new 1924 Model F

$6.50 PER PAIR Complete

This is the standard 3,000 ohm "Red-Head." The 1924 Model F has eleven improved features. Sensitive and fine-toned; aluminum case; famous brown-red ear caps; military headband; high-grade cord.

The new 1924 "Red-Head" Jr.

$5.00 PER PAIR Complete

The Junior Model has most of the quality features of the standard Model F here described. The resistance is 2,000 ohms per set instead of 3,000 ohms. A remarkable value.

"Red-Heads" sent prepaid on receipt of price if you are unable to get them at your dealer's.

THE NEWMAN-STERN COMPANY

Dept. PR Newman-Stern Bldg. Cleveland

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POPULAR RADIO with Your Other Favorites—at Bargain Club Prices!

But you must act quickly. These offers hold good only up to midnight December 15th, 1923

GLANCE over this big list of magazine bargains that have been arranged for your benefit. Here is your chance to get almost any magazine you want—and by ordering *now* with a year's subscription to POPULAR RADIO you get *both* magazines at special low prices.

If you are already a subscriber to POPULAR RADIO or to any of these other magazines, these special club offers allow you the privilege of renewing or extending your subscription *at a considerable saving of money.*

As you know, the subscription price of POPULAR RADIO advances from $2 to $3 a year, effective December 15th, 1923. Yet practically all of these magazine combinations are figured at a price for each magazine that is lower than even the present subscription price.

Fill your magazine requirements *now* for the coming year and save money. Simply check the offer you want and mail the coupon below, with your remittance, without delay.

A Christmas Suggestion

All subscription prices quoted are for one full year, and may be sent to *one* or to *separate addresses* unless otherwise noted. This gives you the opportunity of placing your own subscription for POPULAR RADIO, and having the other magazine sent to some friend as a Christmas gift.

But do not delay. These offers are good only until December 15th, 1923. After that date POPULAR RADIO advances in price and these offers will be withdrawn. Safeguard yourself *now* against POPULAR RADIO's raise in price, and in addition get these other magazines at special bargain club rates!

(This offer expires midnight Dec. 15, 1923.)

McCall's **Popular Radio** $3.00 Reg. For..... **$2.40**	**Modern Priscilla** **Popular Radio** $4.00 Reg. For..... **$3.25**
Youth's Companion (52 issues) **Popular Radio** $4.50 Reg. For..... **$3.75**	**Scientific American** **Popular Radio** $6.00 Reg. For..... **$5.25**
American Magazine **Woman's Home Companion** (both to one address) **Popular Radio** $6.00 Reg. For..... **$5.00**	**Pictorial Review** **Modern Priscilla** **Popular Radio** $5.50 Reg. For..... **$4.50**

Or You Can Make Up Your Own Club of POPULAR RADIO With:

American Boy	$4.00 reg., for...	$3.75
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Collier's (52 issues)	4.50 reg., for...	3.75
Country Life	7.00 reg., for...	6.25
Delineator	4.00 reg., for...	3.25
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Judge (52 issues)	7.00 reg., for...	6.25
Life	7.00 reg., for...	6.25
McClure's	5.00 reg., for...	3.90
Mentor	6.00 reg., for...	5.25
Movie Weekly	7.00 reg., for...	6.25
People's Home Journal	3.25 reg., for...	2.65
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Popular Science Monthly	4.50 reg., for...	4.25
QST	4.00 reg., for...	3.80
Radio	4.50 reg., for...	4.00
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Sunset	4.50 reg., for...	3.75
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Collier's	$3.75 less $1.75 =	$2.00
Radio News	4.00 less 1.75 =	2.25
POPULAR RADIO, added at only		1.75
Remit this amount		**$6.00**

POPULAR RADIO, Dept. 121,
9 East 40th Street, New York City.

Enclosed is $..... Please see that yearly subscriptions are at once entered in my name for each of the magazines I have checked in the special bargain club list at the right.

tubes ...
"Tri-Coil" ...
or C301A tubes.
"Tri-Coil" Type 9 ...
C299 W. D. 11 or 12 tube.

Only $2.00 ..... State.....

At your dealers—otherwise by ... R *after the name of the magazine,* postpaid on receipt of purchase pr... WAL.)

... will be quoted on request.

Free illustrated drawing of one tube "Tri-Coil" Circuit, which will operate loudspeaker, on req...

108

BROOKLYN METAL STAMPING CO
718-28 Atlantic Avenue, Brooklyn, New York

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The New 1924 Model "4-Way" Switch Plug!

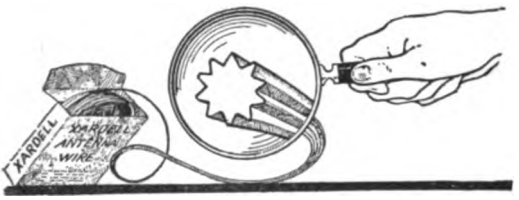
Many refinements have been added to make this the best radio plug.

—a switch plug which makes it possible to tune in through head set and switch in loud speaker by turning dial. Two head sets can be readily attached, or one head set and loud speaker. Both can be used at same time or either one alone. ***Order yours TODAY.***

$1.50

FOUR WAY CO., 29 Worthington St., Springfield, Mass.

DX-10-POINT



ANTENNA WIRE

$2.00

PER HUNDRED FEET

Designed for long distance reception and is different and better than the usual make-shifts, being hard drawn from the finest copper, having a corrugated surface with ten collecting points on the circumference. This gives a greater collective surface to the high frequency radio currents. The result is extreme sensativeness and increase in range and clearness of any set from the simplest Crystal to the finest multiple tube receiver.

Use this antenna wire and enjoy the full possibilities of your set.

Sold in coils 100 feet, 200 feet and 500 feet. Order direct or from your nearest dealer.

Dept. R

Xardell Corp.
UTICA, NEW YORK

Critical Circuits

REQUIRE GOOD MICA CONDENSERS

The FRESHMAN is so designed that constant equal pressure is exerted on the condenser plates over the entire area. They are the only condensers that do this and therefore the only condensers that avoid noises, which are due to variable pressure on the plates.

Capacity	Each	Capacity	Each
.0001	$ .35	.0025	$ .50
.00015	.35	.003	.60
.00025	.35	.0035	.70
.0002	.35	.004	.75
.0003	.35	.005	.75
.00035	.35	.006	.75
.0005	.35	.007	1.00
.0004	.40	.008	1.00
.0006	.40	.01	1.00
.001	.40	.015	1.50
.0015	.40	.02	2.00
.002	.40	.025	2.50

Ask your dealer or write for our free diagrams of the Neutrodyne, Sensational New Kaufman No. 2, Flewelling and other circuits.

At your dealers, otherwise send purchase price and you will be supplied postpaid

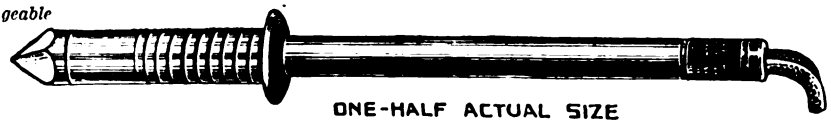
Chas. Freshman Co. Inc.
Radio Condenser Products
106 SEVENTH AVE., NEW YORK

METALECTRIC SOLDERING IRON

(Indestructible All-Metal Quality Instrument—"GUARANTEED")

"Designed to meet the requirements of the discriminating assembler"

Interchangeable Tip



ONE-HALF ACTUAL SIZE

$5.50 *"Worth It"*

Operates with the Simplicity-Comfort-Ease and Efficiency of a Pen

of your dealer or write

POST ELECTRIC CO., Mfrs. (Instruments Division) 30 East 42nd St., New York

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The BATES EAR CUSHION

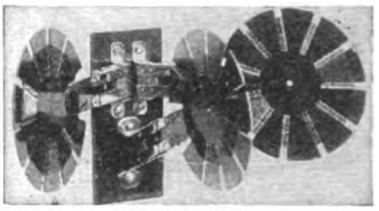
No finer Christmas gift for radio fans. Supreme comfort and keener hearing. Slips over any radio phone.

POSTPAID ANYWHERE IN U. S. $1.00

DEALERS: Write for special discounts. Fastest moving radio accessory on the market.

BATES & COMPANY

1520 Montana St. Chicago, U. S. A.



Patent Pending

The GOODMAN is the niftiest short wave tuner on the market. Awarded certificates of merit. Our pamphlet tells all about it. Send for one. Price $6 and PP. on one pound.

L. W. GOODMAN, Mfr., Drexel Hill, Pa.

RADIO FANS

Tune in on station

W E A F (New York)

every Thursday at 8:50 P. M. and listen to a story or article selected from

HEARST'S

INTERNATIONAL

This is one of the most popular weekly features "on the air"

FREE

Write for Free Copy of the Latest Radio Reprint A. It contains a complete story from Hearst's International Magazine.

Address Radio Editor, Hearst's International Magazine, 119 West 40th St., New York City

Cockaday Coil Set $2.50

Including full size blue prints of panel layout, complete picture hookup, and fully illustrated instructions for construction and operation.

Coils are fully assembled, made exactly as specified by Mr. Cockaday, D coil bank wound. Far more efficient than any home made coils.

Standard parts for this sensational circuit—panel, coils, condensers, verniers, variable resistance, vernier rheostat, socket, double jack, dials, switch, contact points, posts, busbar wire, spaghetti, etc. (no tubes or phones).

Complete for $11.65

Postage additional on all shipments

Send No Money. PAY THE POSTMAN

All Goods Shipped Parcel Post C. O. D.

RADIO SURPLUS STORES

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FOR SALE

BROADCASTING STATION

500 Watt Master Oscillator

Heising Modulation

Now in operation. Public opinion classifies this station as one of the best in the country. No fair offer refused.

ADDRESS, DEPT. S., POPULAR RADIO

TO the manufacturer of one or more articles of meritorious radio equipment, this organization, well experienced in the trade of Spanish and Portuguese speaking countries, offers a service of exceptional interest.

We now handle the export business of Dubilier Products, Burgess Batteries, Radio Service Labs., Freed-Eisemann and Scholes Radio and Mfg. Corp., and are equipped to take on one or two additional high grade lines. Full information and statistics on market conditions in these countries will be given confidentially on request.

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NEW YORK CITY

"LET ACMEDYNE IN EVERY HOME"

with

TELOS ACMEDYNE

VARIO-FORMERS

DANZIGER-JONES, Inc.

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Loud Speaking Crystal Set

AT LAST

You can add a loud speaker to any crystal set by using the STEINMETZ Amplifier costing only $8.50. Guaranteed to operate on any kind of crystal set regardless of what type it is, or we will refund your money. By using your crystal set with this amplifier music is brought in as clear as a bell and can be heard all over the room. Amplifier uses dry cell tube

Write for our complete catalog and also information on a highly efficient detector and two-stage amplifier at $22.50

STEINMETZ WIRELESS MFG. CO.

Manufacturers and Engineers

5703 Penn Ave. Pittsburgh, Pa.

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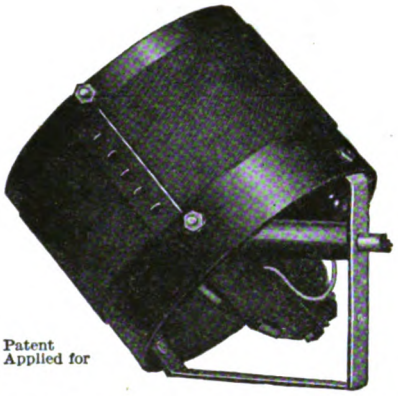
HARTMAN



Patent Applied for

$4.50 VARIOCOUPLER $4.50

Here is a distinctively high grade Variocoupler at an exceptionally low price.

Check the following points and verify this claim.

(1) Spider web rotor. The only means of obtaining minimum coupling. (2) Pig tail contacts. (3) Bakelite tube. (4) Green silk wire. (5) No live brackets. (6) Improved taps. (7) Dead shaft and no capacity effect in tuning. (8) 180° dial adjustment without the rotor being submerged in stator field.

THE HARTMAN ELECTRICAL MFG. CO.
Mansfield, Ohio

BRANSTON RADIO
"Standard of the World"

LOOK FOR THIS TRADE MARK CARD IN YOUR DEALER'S WINDOW OR SALESROOM

Leich Radio Products

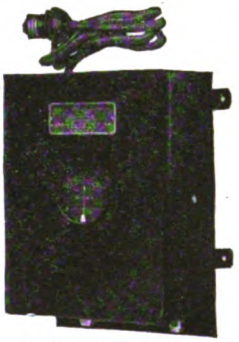
Leich Non-Tune Rectifier

Needs no attention while in operation. Power interruptions automatically disconnects storage battery. Starts charging again as soon as power is on.

The Non-Tune is furnished in two types, one for charging A batteries, the other B batteries.

No. 16 Non-Tune Radio Rectifier to charge 6 volt battery..... **$19.00**

No. 10 Non-Tune Radio Rectifier to charge B batteries..... **12.00**



No. 16 Non-Tune Radio Rectifier, Price $19.00

Leich Comfortable Headphones

Leich Headphones bring in broadcast reception in pleasing natural tone like listening to the artists direct. Regardless of how expensive your receiving set, if you do not get a natural tone, if you do not get the overtones, the reception is flat.

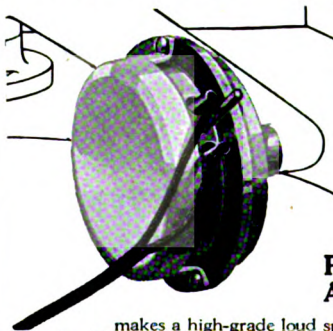
Ask your dealer to let you "listen in" with Leich Phones. You will appreciate the difference.

1-B-2000 Leigh Radio Headphone..... **$6.00**

Ask your dealer for Leich Radio Products—write us for booklet 101-I giving complete list and prices.

LEICH ELECTRIC CO.
GENOA, ILLINOIS

ACOUSTICOLA



$10.00 Loud Speaker

Phonograph Attachment

makes a high-grade loud speaker of any phonograph. Extra large size. Wonderful adjustment lever tones down local stations and strengthens and clarifies weak signals from distant stations by instantly increasing or decreasing distance between poles and diaphragm. Just like focusing a camera.

ACOUSTICOLA STANDARD MODEL **$22.50**
Same lever equipped, giant size unit with non-metallic horn, 21½" high; bell 10" wide

ACOUSTICOLA GRAND **$35.00**
With Cast Aluminum VIBRATIONLESS Horn—the world's finest loud speaker.....

TRIMM HEADPHONES
"Professional" $7.65 **"Dependable" $5.00**

With every Trimm product we give a LIFETIME Guarantee. Write for folder.

TRIMM RADIO MFG. CO.
Dept. 59 **24 S. Clinton St., Chicago**

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Let Us Help You Get the Most Out of this Radio Season

Prompt Shipment—Efficient Service

We carry complete stock of all fast moving nationally advertised Radio Supplies. Orders filled same day received. This means money to you.

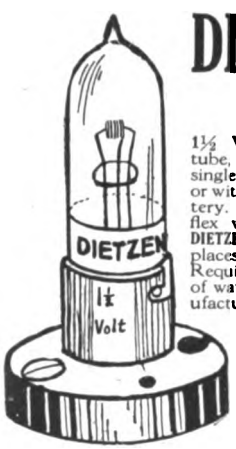
SEND TODAY: for complete catalog Radio Supplies priced to make you a profit. We list over a thousand items.

We are the largest exclusive radio jobbers in the middle west

HUDSON-ROSS
123 W. Madison St. Chicago

DIETZEN MIDGET TUBE

The Little Tube for Big Results



1½ Volt Vacuum tube, operates on single dry cell, with or without "B" battery. Great for reflex work. The DIETZEN MIDGET replaces the crystal. Requires no adjustment or change of wave lengths. Order from manufacturer direct. Send for your tube today, enclosing currency or money order. (No stamps)

$1.00 Special Socket 40c

DIETZEN, Inc.
71 Cortlandt Street
Dept. P New York

RUSONITE

CRYSTAL RECTIFIER

(Patent Pending)

THE PERFECT SYNTHETIC CRYSTAL DETECTOR
SENSITIVE OVER ENTIRE SURFACE

No Hunting for "Spots." Loud and Clear. Endorsed by Thousands of Satisfied Users

Sensitiveness Guaranteed — Price Mounted **50c**

14 K. Gold Supersensitive
RUSONITE CATWHISKER, Price **25c**
Permanent. Will not Oxidize

RUSONITE REFLEX CRYSTAL
Manufactured Expressly for Reflex Circuits. Will Stand Up Under Heavy Plate Voltage
Guaranteed — Price Mounted **$1.00**

WATCH FOR OUR NEW FIXED CONDENSER
Order from your dealer or direct from
RUSONITE PRODUCTS CORP.
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Hear them all clearly

With a Premier

"HEGEHOG"

Trade Mark

Audio Transformer

Little but mighty—a wizard for volume and tone quality. Look at the cut. It shows the "HEGEHOG" one half actual size. "Small," you say. Yes, but inside this "Little Wonder" you will find more efficiency, more reproduction volume, and less distortion than found in any other Transformer, regardless of size, price or design. The secret is in its patented construction. *It is shielded 100% against foreign noises.* Fully guaranteed. You'll want them in your next "hook-up," so get all the facts NOW. Our Free Bulletin No. 97 gives them fully. Send for it.

Premier Electric Company

3807 Ravenswood Ave. :: Chicago

Price, $3.50

Cut one-half actual size

Ask for and insist on "HEGEHOG" at your dealer's

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF POPULAR RADIO
Published monthly at New York, N. Y., for October 1, 1923.

STATE OF NEW YORK } ss.
COUNTY OF NEW YORK }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Kendall Banning, who, having been duly sworn according to law, deposes and says that he is the Editor of POPULAR RADIO, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, POPULAR RADIO, Inc., 9 East 40th St., New York City; Editor, Kendall Banning, 9 East 40th St., New York City; Managing Editor, None; Business Managers, none. 2. That the owner is: POPULAR RADIO, Inc., whose stockholders are: New Fiction Pub. Corp., 9 E. 40th St., New York City, whose stockholders are: Abel I. Smith, 120 Broadway, New York City; Marjorie L. Sargent, Fremlum Point, New Rochelle, N. Y.; H. B. Emerson, 9 East 40th St., New York City; Metropolitan Finance Corporation, 9 East 40th St., New York City; whose stockholder is Harvey Fisk & Sons, Inc., 34 Pine St., New York City, whose stockholders are: Frank B. Ansted, Connersville, Ind.; William G. Audenreid, Jr., 34 Pine St., New York City; Harvey Fisk, 34 Pine St., New York City; Pliny Fisk, 34 Pine St., New York City; Lorin L. Horner, 34 Pine St., New York City; Henry K. Hooker, 40 State St., Boston, Mass.; Wilfred Jessup, 34 Pine St., New York City; James Magill, Land Title Bldg., Philadelphia, Pa.; F. O. Marsh, 52 Wall St., New York City; Joseph R. Paul, Westinghouse Bldg., Pittsburgh, Pa.; Carlton W. Rich, 60 State St., Boston, Mass.; Richard U. Sherman, 246 Genesee St., Utica, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) KENDALL BANNING, Editor.

Sworn to and subscribed before me this 1st day of October, 1923.
[SEAL] J. E. AHLQUIST, *Notary Public.*

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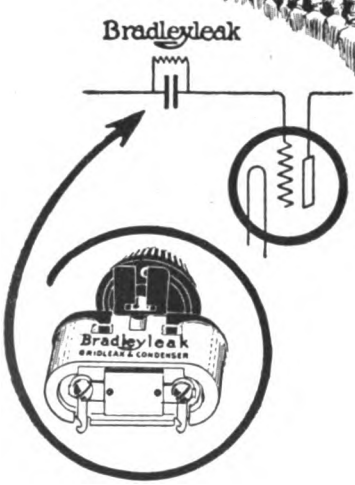

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C-200	2 Megohms
C-299	2 to 5 Megohms
C-301-A	2 Megohms
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UV-201-A	2 Megohms
WD-11	3 Megohms, or more
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CLEAR-*for the Crowd!*

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With the ordinary loudspeaker, there is something lost—and something added. The lost tones are the overtones and partials that give music or voice its richness, color, and personality. The added sounds are the independent vibrations of the horn itself—metallic—hard—and grating.

To erase these faults was the problem. Not to make another loudspeaker with the limitations of the old one—but to create a new one *without* those limitations. And we have it, in the RADIOLA LOUDSPEAKER.

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To get the deep tones of the organ—the full range of the piano—the highest notes of the violin—all with full color and richness.

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This was a problem for acoustical experts. The mere shape of a horn can *make* it or ruin it. Each curve of the RADIOLA LOUDSPEAKER horn has been developed for pure tone reproduction. And it is made of a composition with no audible vibration of its own—amplifying without adding.

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